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THE RELATIVE VALUE OF THE SPECIAL SENSES TO THE SURGEON*

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A WIT recently said, "The specialist is one who knows more and more about less and less." This might be modified to "Most of us know less and less about more and more," which is perhaps truer of the surgeon with regard to the nervous system than with regard to any of the other great divisions of medicine. Although it is undoubtedly true that any attempt by one who is not a specialist to obtain a good working knowledge of the details of the remarkable scientific advances in this field would be futile, it should not be impossible for one to obtain a valuable perspective.

On the wall of the amphitheatre of one of the large English hospitals, facing the students, are five words: "Sight," in large letters; "Touch," in smaller letters; "Hearing," in still smaller letters; "Smell," in fine print, and last, in print so small as to be scarcely distinguishable across the room, "Taste," indicating the estimation of the great surgeon who occupied this amphitheatre for more than thirty years of the relative values of the special senses to the surgeon.

As time goes on I am more and more convinced that the relative values of the special senses to the surgeon as expressed by this master so graphically are approximately correct. If one were to estimate from the accuracy rather than the value of perception, perhaps the sense of smell would come first, because man is able to recognize through the sense of smell odors so delicate that there are no instruments of sufficient precision to give cognizance of them. Vapors and gases represent colloid and molecular combinations, but these subdivisions of matter lie in the ultramicroscopic field beyond direct vision.

Again if one takes as a guide the primitive character of the senses, touch would come first because it is related to the earliest form of sensation, namely, stimuli which affect the coverings of the body, as in the subvertebrate, the amphioxus.

To animals that moved about to obtain food, some form of consciousness became essential.

Receptors, the earliest form of nervous system, are apparatus that receive

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impressions from surroundings and activate other structures. Sherrington has defined a receptor as the peripheral apparatus which receives a stimulation.

Man's distance receptors consist of the organs of the five special senses of touch, taste, smell, hearing, and sight. All these senses have their origin, from the standpoint of embryology and comparative anatomy, in the sensations originally derived from the external envelopes which protect the organism. As the animal organisms became more complex, receptors were more or less connected with the cerebrum, the sense organ of intellectual life which had its origin in the olfactory ganglion of the invertebrates. The neopallium, that part of the brain which did not originate in the olfactory ganglion, gives a fuller representation of all the senses and carries on the conscious as well as the unconscious activities in the control of the mechanism of life.

In the lower animals (non-primates) the sense of smell controls behavior because it is the only sense directly connected with the expanded olfactory ganglion which represents the cerebrum in the lower vertebrates. The other senses are relayed, so to speak, through various centres and may be garbled in transmission.

In the primates, for instance man, the cerebral cortex, which is the seat of intellectual functions, underwent huge expansion. This expansion came coincidentally with the development of vision, dwarfing the olfactory origin. Vision thus secured direct access to the cerebral cortex, while smell retains direct connection with the cerebrum, and is marvelously sensitive; it has small function as compared with vision.

The gray matter of the cerebral convolutions records and classifies impressions, analyzes experience, and activates emotions. Intellectual functions cannot be ascribed entirely to the special senses, but are rather the sum total of both external and internal sensory impressions interwoven into a complex mechanism controlling behavior.

The sense of touch is a pressure sense. In common parlance, touch in man refers to the hands, which the upright position of the human body has freed for highly specialized training.

The sense of taste and the sense of smell are chemical senses and are closely allied. The sense of taste depends on nerve endings largely in and about the tongue and is perhaps the least important and the least delicate of any of the special senses, recognizing only four types of food or modifications thereof: sweet, sour, bitter, and salty. The qualities ordinarily known as flavors are not dependent on the sense of taste, but on the sense of smell which is extraordinarily delicate, recognizing ultramicroscopic substances suspended in the air as vapors and gases. The sense of taste alone could not distinguish an onion from an apple.

Perhaps the reason for failure of the sense of taste to measure up to that of many of the lower animals is that the mobile tongue of the lower vertebrates is used not only to bring food into the mouth and to aid in mastication, but also to determine the edibility of various materials. The tongue of man is not a descendant of the tongue of the lower vertebrates, but on the contrary

is a relatively new development for other purposes, such as speech, as well as sensation.

The olfactory cells on which the sense of smell depends are arranged in bundles and each cell has a hair ending. The function of these hair endings may be to recognize the impact of molecular colloid substances in gases and vapors (either from size or rapidity of motion) as odors, just as differences in the speed and length of rays of refracted light are recognized by the eye as colors in the lines of the spectrum.

The sense of smell in man is represented by only about one square inch of pigmented olfactory nerve cells, a very small amount as compared with the olfactory organ in many of the lower animals. In the hound, for example, this sense is exceedingly accurate while the sense of sight is defective. The approximate location of the quarry is determined by its odor, but the exact location is visual, because the sense of smell does not possess the faculty of recognizing time, space, or motion. The deer recognizes its enemy by the characteristic odor carried by air currents an almost incredible distance. It is interesting to note that the new-born fawn has no odor during the early days of its life, and thus is protected against its enemies in the days of its helplessness. The pigmented cells are necessary to convey odors to consciousness. Albinoes have no pigmented cells and therefore have no sense of smell. Sheep-raisers send the albino lambs to the butcher because it is known that they cannot distinguish between noxious weeds and proper food and sooner or later would die from poison.

The sense of hearing is to a certain extent a pressure sense. Among the lower vertebrates, fish have a so-called sixth sense situated in the lateral line labyrinth organ of Leydig which enables them to appreciate pressure, depth, and equilibrium. The ear of land animals responds to sound waves and pressure changes in the air as that of the water vertebrate does in water. This sensitiveness to change in air pressure will be noted on the descent from mountains to a lower region, and in the length of time a sound requires to reach the ear. The relation of equilibrium to the fluid contained in the semicircular canals is an evolution from a water vertebrate to a land vertebrate. A cat dropping from a height lands on its feet and in the process of righting the body during the fall the head turns first, due to the speed of the reflex mechanism of the labyrinth adjustment.

It is interesting that the organ of Corti in the ear contains certain fine hairs about which little seems to be known, although Helmholtz sixty years ago suggested that the varying lengths of these hairs might have to do with the recognition of tones. Our knowledge of the radio, little as it is, suggests that the possible function of these hairs on the organ of Corti is to receive vibrations in the air and to distinguish certain wave lengths as pitches of sound. The sense of hearing in certain of the lower animals is more acute than in man. The cat recognizes tones of higher pitch than can be recognized by man. The bat hears the wing tones of insects pitched in a key beyond recognition by the ears of man.

In one respect the sense of hearing and the sense of smell are unlike. The sense of hearing as a rule diminishes with age, whereas the sense of smell often grows keener; it is usually more delicate in women than in men.

Picturesquely speaking, 95 per cent. of man's information is obtained either directly by visual means or indirectly through visual training of the other special senses. The direct connection of the eyes with the cerebral cortex controls behavior in man and not the superior mechanics of the eye, which in many respects is inferior to that of the lower animals. For instance, if man had the telescopic vision of the eagle, he could read ordinary print at 500 feet. In many of the lower vertebrates each eye sees independently and in only two diameters, length and breadth, whereas in man binocular vision gives sight in three diameters, length, breadth, and depth. The snake has no macula lutea and sees only objects in motion.

Certain fish in the depths of the sea radiate cold light, not necessarily connected with the eye, but emanating from specialized cells in various parts of the body, differing according to the habits and necessities of fish life, which permits a certain amount of vision. Cold light is also seen in the glowworm, the fire-fly, and other animal organisms. Much research is being carried on to determine the nature of this light, in the hope that it may be used instead of the hot light obtained by present-day oxidation methods.

The introduction of the microscope by the Jannsens in 1590 revolutionized medicine. This discovery came too late to benefit Harvey (1578–1657) greatly, but it gave the hand lens to Hunter (1728–1793) and the modern microscope to Lister (1827–1912) and Pasteur (1822–1895).

We now face through ultramicroscopic methods a new advance in medicine by means of physics and chemistry of almost equal importance to the invention of the microscope. With the X-ray the atom has been analyzed. Belchier of Guy's Hospital, London, introduced the dye, madder, in 1764, for the injection of blood- and lymph-vessels to aid anatomical dissection. Through modern colorimetry methods have been perfected for making various laboratory tests of the greatest value. The phenolsulphonephthalein test of Rowntree and Geraghty for urea filtration through the kidney has been possible, since the molecule of phenolsulphonephthalein is the size of that of urea and is eliminated as that of urea is eliminated. The phenoltetrachlorphthalein test for hepatic function is the best known if jaundice is not present.

Photography has been so developed that in 1/12,000,000 of a second a bullet in flight with a muzzle velocity of 3000 feet a second can be photographed as though standing still. Through such photography the eye can make its investigations at leisure.

The value of vision lies not alone in sight, but in education of other senses as well, as exemplified in Helen Keller, Ole Bull, and a host of others born without certain special senses but with wonderful intelligence when trained by the eyes of the educator.

The relative value of the sense of taste is the least important. It should not be neglected, however, for it was through the sense of taste that sugar in

the urine of the patient with diabetes was first detected and its significance determined.

The sense of smell, in spite of its extraordinary accuracy and delicacy, is but a degree more important to the surgeon than the sense of taste. Nevertheless, every student should be trained to use the sense of smell. The older practitioners were often adept in this now neglected field. It requires but little training for the surgeon in passing along a corridor in a hospital to distinguish between the odor from a fistula in the sigmoid and that from a fistula in the cæcum, ileum, or jejunum. At times the odor of the breath of a poisoned patient gives a clue to the nature of the chemical poisoning.

As between the sense of hearing and the sense of touch, arguments can be brought up from both sides. The discovery of the stethoscope, and the use of percussion and auscultation marked a great advance in medicine, but we all know the inaccuracy of those methods and how little reliance could be placed on them until the X-ray and surgical operation enabled us to make correction of the fallacies.

The old adage that the hand is quicker than the eye is true, but the hand in question was that of a prestidigitator, and was trained by the eye.

If there is a sixth sense, it is intuition, that instinctive summing up of memories and other evidences collected by the special senses and correlated in man's consciousness.

There is a growing tendency in the medical profession to depend more and more on mechanical aids and laboratory tests, with neglect of those fundamental senses on which we are entirely dependent for all our knowledge of the outside world. This should not be.

ABDOMINAL SURGERY IN THE PRESENCE OF INFECTION CAUSED BY THE STREPTOCOCCUS HÆMOLYTICUS*

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It is occasionally possible and legitimate to enunciate broad principles of treatment by the study of a single case. The results obtained in an individual instance may illustrate in a striking fashion the value of employing certain methods of treatment which are based on sound theory or on experimental investigation and clinical experience. With this object in view I venture to record a case of infection by the streptococcus hæmolyticus originating in a tuberculous Fallopian tube and implicating the peritoneum and the superficial wound in the abdominal parieties. An attempt will be made to assess the value of certain factors which contributed in securing a successful issue in this case of virulent infection, complicating an abdominal operation, after a long and tedious illness. The case is as follows:

O. E., aet. seventeen, had complained of pain in the right iliac region twenty-four hours before operation. During the week previously she had some small boils on the back which were incised; these had healed. She felt nauseated but did not vomit and she had passed a disturbed night. When seen by the writer three hours before laparotomy she had a temperature of 103° F., pulse 130, and a patchy dry and furred tongue. The respirations were chiefly thoracic with a considerable degree of splinting of the abdominal wall. Palpation elicited exquisite tenderness in the right iliac region; palpation on the left side low down produced pain in the right side. There was slight comparative rigidity of the right lower quadrant of the abdomen. The leucocyte count was 23,500. A diagnosis of acute appendicitis was made and immediate operation advised.

The abdomen was opened through the outer border of the right rectus muscle. The appendix, which was swollen and congested, lay deep in the pelvis and was there adherent to a greatly distended right Fallopian tube. The tube was twisted acutely backwards and was firmly adherent at the bottom of the pouch of Douglas. The peritoneum about the appendix and tube was markedly congested. The appendix was first mobilized and removed. The tube was also freed and about a drachm of material resembling pus escaped, but it did not noticeably diminish the size of the tube. The right tube and ovary were removed. The abdomen was closed without drainage. The operation throughout was carried on with the least possible amount of traumatism, special care being taken to prevent damage to the peritoneal surfaces both visceral and parietal. The only structures handled or bruised were those which were removed, viz., the appendix, the tube and the ovary.

Laboratory investigations showed that the Fallopian tube contained pus: a direct smear showed many pus cells and Gram-positive cocci in chains. Culture showed Gram-positive cocci in short chains and in small scaly colonies, streptococcus hæmolyticus. Histological examination showed tubercle in the tube in which the bacillus tuberculosis was stained successfully in the tissues, where also streptococci were found in large numbers. The appendix showed an acute inflammatory condition with polymorphonuclear infiltration.

Post-operative History.—On admission to the hospital her pulse was 150 per minute

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and her temperature 103.4° F. After operation the temperature came down very gradually until on the ninth day it was 99° F. The pulse, however, remained at 110–120 per minute. The stitches were removed on the ninth day and a few hours subsequently the temperature again rose to 102° F. These nine days were marked by an undue amount of restlessness. On the tenth day a scanty discharge of sero-pus escaped from the wound. During the next few days the temperature varied from 99 to 102° F. At no time did she exhibit any symptoms of peritonitis, the bowels moved freely, the abdomen remained flat, and she took nourishment well.

On the fourteenth day the temperature rose to 103.6° F. From the wound was obtained a pure culture of streptococcus hæmolyticus. The blood culture was sterile, the leucocyte count 15,600. At this juncture, Doctor Maitland gave her ¼ c.c. of 1 in 200 phenol solution intravenously. And this was repeated every second day until seven such treatments were given. Some definite results were obtained. A smear taken from the wound before and after the intravenous administration of phenol showed that markedly increased phagocytic action resulted. The opsonic index was greatly increased by the phenol. In addition there was a gradual recession and then a sudden rise in both pulse and temperature with increased, free discharge from the wound.

On the twenty-sixth day after operation and after the fourth injection of phenol, the superficial wound was opened up, under gas anæsthesia, for the purpose of securing better drainage. The infection was found to be quite superficial: the aponeurosis was intact. The superficial fat and fascia presented a nasty grayish ground-glass appearance with dirty pulpy material here and there. Pelvic examination showed everything normal in that situation. Two large drainage tubes were secured in this superficial wound. The phenol injections were continued at varying intervals until, in all, eleven treatments were given. The last injection being given on the forty-third day after operation.

After several remissions of high temperature and pulse she gradually improved and, six weeks after the operation, the wound had largely closed. She still had an occasional rise in temperature to 100° F., but her general condition had improved vastly. She subsequently went to her home with a discharging sinus, this remained open for some months. Her doctor pronounced her well seven months after operation. For the past four years, since the operation, she has enjoyed perfect health.

Mixed infection in tuberculous lesions is very common. In this case, however, while it was obvious that an acute infective process of a virulent type existed, one was not able to determine its true nature until bacteriological investigations were carried out. The operative treatment in such cases demands careful technic and sound judgment. We propose to discuss certain features of the technic which may be employed.

Trauma.—The uninjured peritoneum possesses a high degree of resistance to infection. A principle of treatment, therefore, which is essential to observe in all abdominal operations, is to prevent injury to that delicate endothelial surface. It is possible to carry out extensive manipulations, within the abdomen, without causing damage to the peritoneum other than that of the serous surface of the organs which we remove. Thus an adherent appendix may be removed without damage to the surrounding structures. It may be necessary to handle the appendix itself roughly in our manipulations but, with care, any bruising and the damage done by pressure and friction may be confined to the appendix, so that after the appendix is removed a normal, uninjured peritoneum is left behind. The same principles should be observed in per-

forming a hysterectomy or in resection of the intestine for malignant growth, etc. It may seem a very elementary point, but the observance of it is essential for successful abdominal work. Incidentally it is an argument for extensive parietal incisions so that adequate inspection may be made of the field of operation. A good illustration is afforded in intestinal obstruction of unknown origin. Here an extensive incision should be made, the distended gut should be allowed to escape freely into soft towels soaked in normal saline solution, the seat of obstruction is sought with the greatest gentleness and the cause removed with the minimum amount of damage to the peritoneum.

This principle of minimizing the damage to the peritoneum was carefully observed in the case under consideration.

Drainage.—One has heard the dictum stated "when in doubt drain." It is, in our opinion, a most dangerous and fallacious doctrine. To put it strongly one may assert that to have introduced a drainage tube, in the case just cited, would have killed the patient! An adverse criticism of the use of the drainage tube many years ago was to the effect that "the drainage tube is often the cause of the infected matter which flowed through it." While this may be true, we all know it is essential to drain a septic focus in the peritoneum when we know that suppuration will continue and that general peritonitis is likely to occur if we close the abdomen without drainage. Clinical experience teaches us that fact. On the other hand, it may be possible, it *was* possible in the case under consideration, to remove the septic focus and leave undamaged peritoneal surfaces behind.

In our opinion it requires most careful judgment to determine when to drain and when to close without drainage. We cannot be dogmatic on the question of drainage. The point one wishes to insist upon is that while it may be absolutely necessary to drain in many instances, it is equally essential to desist from drainage in others. The very presence of the drainage tube, in causing damage to the delicate peritoneum, may result in a spread of the infection, thus resulting in the very disastrous extension of the trouble which we seek to avoid.

We often have occasion to observe that the peritoneum possesses a higher degree of resistance than the superficial tissues of the abdominal wall. In that respect our case affords a good illustration. It frequently happens in the case of the removal of an acutely infected appendix, when the abdomen is closed without drainage, that the patient recovers without peritonitis but the superficial fat and fascia become the seat of infection and suppuration. The presence of a drainage tube in the abdomen would, in such cases, be a distinct menace. In the case cited a drainage tube in the abdomen would almost certainly have resulted in an invasion of the peritoneum by the streptococcus hæmolyticus.

Phenol.—The value of intravenous administration of phenol is worth consideration. Dr. H. B. Maitland, formerly one of my colleagues in the

University of Toronto, was good enough to carry out the intravenous administration of phenol as recited in the clinical history. Doctor Maitland is now on the staff of the Lister Institute in London and he has sent me the following personal note on the use of phenol in this case: He states as follows:

"Phenol was given to this patient to obtain a non-specific increase in the bactericidal value of the blood. In the sense that all the details of the mechanisms of such increase have not been worked out, the employment of phenol may be regarded as empirical, but on the other hand, some experimental results have been obtained which warrant its use on the basis of well-known principles. It can be shown experimentally that certain small concentrations of phenol added to defibrinated blood will, after a short incubation at 37° C., increase the phagocytic value of the blood. It is thought that phenol acts on the leucocytes. The effective degree of concentration varies somewhat from one person to the next, and should be determined for each case. The dose for an adult has usually been from ¼ to ½ c.c. of 1 in 200 phenol intravenously. The increase in phagocytic value comes on in from one-half to one hour and is probably of short duration (less than twenty-four hours). Daily administration therefore may be advisable, although some evidence has been obtained that stimulation could be carried too far if daily injections were continued over too long periods."

"In two cases where pus had collected, and to which phenol had been given, films from the discharge showed a marked increase in phagocytosis after phenol had been administered. Observations on the influence of phenol in phagocytosis in discharges from wounds have not been numerous, but these two cases suggest that the response to phenol may not be limited to the blood."

Doctor Maitland explains that the technic he employed in testing the efficacy of phenol in this case was to add various concentrations of phenol to defibrinated blood (saline as a control), incubate at 37°–50 minutes, and make opsonic determinations with each sample of blood plus phenol—using staphylococcus in the ordinary way as a test organism for opsonic activity.

Defibrinated blood from the case here reported was mixed with the following concentrations of phenol and incubated at 37° C. for 50 minutes. It was then tested for phagocytic value with staphylococcus. The following results were obtained:

	Staphylococci ingested per 100 polymorphs	Phagocytic Index
Blood plus saline	787	
Blood plus phenol 1/500,000	839	1.06
Blood plus phenol 1/1,000,000	733	.93
Blood plus phenol 1/2,000,000	832	1.05
Blood plus phenol 1/4,000,000	926	1.18
Blood plus phenol 1/8,000,000	894	1.13

The optimum concentration was 1/4,000,000—and judging the volume of blood by the patient's weight, one calculated the amount of 0.5 per cent. phenol in saline, it was necessary to give to obtain this concentration.

Summary.—This short paper emphasizes the importance of observing certain principles of treatment which must be observed in our operative technic in abdominal surgery. The avoidance of unnecessary trauma and the exercise of sound judgment in determining the indications for drainage; more particularly does one stress the extreme danger of employing drainage in certain cases and in condemning the theory that the introduction of a drainage tube into the peritoneal cavity is always a safe procedure and that it should be employed whenever one is in doubt. A study of the case cited illustrates the value of the intravenous administration of phenol as a means of increasing the resistance of the individual to infection, particularly when due to the streptococcus hæmolyticus. Evidence is produced to suggest that phenol thus employed increases the phagocytic activity of the blood and probably of the tissues.

SECONDARY OPERATIONS ON THE ABDOMEN*

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The surgeon at the operating table naturally approaches his case with a certain degree of confidence in his ability to correct the presenting pathology. Indeed, it is true that ordinarily, with a thorough understanding of the lesion, together with proper and careful technic, he has the satisfaction of seeing a prompt recovery and of dismissing a satisfied patient. It is the exception that calls forth this paper.

A certain proportion of abdominal surgery, as we all know, is devoted to secondary operations, demanded within a few hours or at a more or less remote period after the first intervention. Some of these operations are unavoidable and the probability of re-operation is known to the surgeon at the primary one, although it is not within his power to prevent it. But there is another group of cases, in which it is more or less difficult to account for a recurrence of symptoms, especially when a mental review of the case in question gives every reason to suppose that the lesion had been efficiently disposed of. Nevertheless, it is not unusual for patients, after a post-operative period of months or years of perfect well-being, to return to the hospital with symptoms suggestive of some trouble related to the first operation. It has occurred to me that a review of our secondary operations might throw some light on the causes that lead to the same, and that a clearer understanding of them may be of value in reducing their number. It is gratifying to me to note that the records of the ably-conducted Follow-up Service at the Lankenau Hospital have materially lightened the work in connection with this study.

We find that the majority of secondary operations are required for the sequelæ of appendicitis, cholangitis, cholecystitis, choledochitis, peptic ulcer, hernia, etc. The responsibility for these sequelæ, I am glad to say, is a divided one, for in many instances the first operation was performed elsewhere; and furthermore, we are able to note that most of the returned patients had presented more or less advanced pathology at the primary operation.

Dividing these secondary operations into an early, a later, and a remote group, it becomes apparent that re-operation comparatively soon after the primary operation in the first two groups is usually demanded because of hemorrhage, secondary collection, obstruction and fistula; and in the remote group, for intestinal obstruction, vicious circle, marginal ulcer, and in rare instances for the removal of a foreign body such as a sponge, instrument, or needle overlooked when closing the abdomen.

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In the later groups the second intervention is most frequently required for adhesions, persistence or return of symptoms of disorders of the biliary or of the gastro-intestinal tract. In the biliary tract, the cause may be inflammation of, or stone in the common or the hepatic duct, inaccessible at the primary operation and later working its way into the common bile duct; or to a chronic cholangitis, or a chronic pancreatitis, developing later as a result of the advanced pathology found at operation, or to adhesions or fistula. In the gastro-intestinal tract the reason for the return of symptoms is very likely due to the omission of a gastro-enterostomy at the original operation, that is, mere excision of a chronic ulcer or mere closure of an acute perforated ulcer.

The remote lesions occurring from several months to several years after the primary operation are chronic, subacute or acute obstruction, due to adhesions; incisional hernia, or recurrent inguinal hernia; marginal ulcer, malignancy, persistent and obstructive pylorospasm after closure of acute perforated ulcer without a gastro-enterostomy. Advanced biliary tract disease, large peptic ulcers with much peri-ulcerous exudate, and diffuse suppurative conditions are especially pernicious since they may lead to pathology requiring repeated operative intervention. This is particularly true of chronic and acute cholangitis, and chronic or subacute pancreatitis in which drainage was not established, or if established was not kept up long enough. Unless each later operation in these cases consists of prolonged drainage, relief may be only temporary and recurrence of the same symptoms in an aggravated form will follow.

Adhesions.—The peritoneum rapidly acquires an astonishing degree of immunity and to a degree becomes insensitive after multiple operations. In our experience, adhesions seem to be more apt to develop in some patients than in others, that is, there seems to be a predisposition to form fibrous bands and pathological peritoneal sheets. On the other hand, cases are occasionally met with when there is every evidence of the presence of an appendiceal abscess with plastic exudate, but the patient refuses operation at the time, and when coming to operation sooner or later, may show absolutely no evidence of previous inflammation. It is true that adhesions form as a part of the battle against infectious processes, and are thus a defensive and purely constructive means of protection used by nature to stop the bacterial invasion. Unfortunately too often they not only limit the infection, but at the same time create a mechanical obstruction. Generally speaking, the formation of adhesions depends on the resistance of the patient and of the peritoneum, as well as on the type and virulence of the microorganism present, the location of the primary affection, the ability of the surgeon to eradicate and to avoid the spread of infection, and the control of hemorrhage, as well as the proper technic, such as the protection of raw surfaces, avoiding trauma, and the kind and amount of drainage material used.

The damage in such cases is due to chronic induration of the delicate submucosal and subseral tissue, whether it be gastro-intestinal, biliary, or intes-

tinal involvement, together with mechanical interference due to contracting or constricting fibrous tissue in the form of membranes, bands or scars, Such a situation may result from a primary local inflammatory process permitted to become diffuse, in which event, even the master surgeon may be compelled to sacrifice local results in order to conserve life, or it may occur from defective technic or haste on the operator's part, thereby changing a benign and simple condition into a malignant and complicated one. The best way to limit the formation of adhesions is to limit the infection within the abdomen.

Intestinal Obstruction.—Acute appendicitis is one of the most common surgical affections of the abdomen, and the operation is always a major surgical procedure. It is also the most frequent etiologic factor in intestinal obstruction. This may occur immediately after operation or may not develop until several months or even years later. In the Lankenau Clinic thirty-one (56 per cent.) of the last fifty-four cases of intestinal obstruction followed operation for appendicitis, the pathology in each instance being a suppurating ruptured or gangrenous appendix with local or spreading peritonitis. Appendicitis also heads the list of the primary causes of secondary operations and owes this prominence to the still prevalent practice of ignoring or misinterpreting cardinal symptoms and delaying action. This accounts for the frequent incidence of secondary collections, subdiaphragmatic abscess, obstructive adhesions, and fistula. For as we all know, all of these may occur in one and the same patient.

Sometimes intestinal obstruction occurs within three or four days after the evacuation of an appendiceal abscess, especially where the terminal ileum had formed a part of the abscess wall. This happens when the appendix lies beneath the terminal ileum and mesentery, and points downward and to the left. I have also seen this occur after the removal of a very long chronically diseased appendix holding the latter position where the appendectomy left a raw surface. In the acute cases the walls of the terminal ileum are found more or less infiltrated and stiff, favoring sagging of the proximal bowel which then becomes adherent either to the wall or to the margin of the wall of the abscess cavity. Where the cavity has been coffer-dammed this is not so likely to occur as where drainage (cigarette or rubber tube drains) has been used. In coffer-damming, the bowel is supported and by allowing the coffer-dam to remain several days the infiltrated bowel wall has a better chance to recover its integrity. Nevertheless obstruction at a much later time may occur. If under the above circumstances I feel any uncertainty at the first operation, I anastomose the ileum proximal to the infiltrated area to the colon. The only regrets I have in this connection are those of omission. One or more entero-enterostomies is good surgery in certain inflammatory conditions with partial or complete obstruction of the small intestine.

Fecal Fistula.—A third possible and very unpleasant sequel of acute appendicitis is fecal fistula. Our records show that in 4620 operations for appendicitis, fecal fistula followed in 222 patients, or an incidence of 4.7

per cent. Of these, 39 per cent. healed spontaneously, 49 per cent. required a secondary operation, and 13.5 per cent. refused operation. The duration of fecal drainage varied from twelve hours, after which spontaneous closure occurred, to nine years of intermittent drainage. Before resorting to re-operation, in the early cases, we wait several days and occasionally several weeks or even months, to see whether spontaneous closure will not take place. Fistulæ of the upper gastro-intestinal tract are more devastating than those lower down. They occur in cases where an extensive operation with considerable drainage has been performed, and a frequent cause again is the appendix with a perforation close to the cæcum. In late cases of suppurative appendicitis pus is often found beneath the diaphragm, the liver, lateral to the ascending colon (external para-colic groove), around the cæcum and terminal ileum, and in the pelvis with occasional foci between the neighboring coils of ileum. These pus collections cause a pressure necrosis resulting in fistula of the large as well as the small bowel. Surgical experience has led me to apply thorough drainage to all these cases and to leave the wound open. But I am not surprised if a fistula develops. A fistula may also result if the drainage is too compact or left in too long. The site of the fistula will of course depends on the location of the damaged tissues. Drainage from a fistula of the large bowel as a rule does not irritate the skin, but that from an opening in the small bowel usually causes considerable irritation and burning. The higher the opening in the small bowel, the more severe the irritation of the skin about the wound.

The operative repair of a fecal fistula consists in inversion of the opening in the intestinal wall by a re-inforced purse-string suture. If extensive destruction of the bowel is present, an ileocolostomy and, in certain cases, resection may have to be done. In the event of recurrence, further resection may be required. It is true that incisional hernia may and usually does occur in these cases when free drainage has been used and only a few retaining sutures hold the wound together. But the gravity of the situation demands heroic measures and free drainage is essential.

The biliary tract offers another fruitful source for secondary intervention. In a series of two thousand seven hundred operations for disease of the biliary tract in the Lankenau Clinic, one hundred and forty-three (5.3 per cent.) were re-operated cases. In a small percentage of these cases the symptoms persisted immediately after the first operation, others were free for several weeks or months, while many were relieved of all symptoms for one or more years, after which time symptoms referable to the biliary tract again appeared. The phenomenon may be due either to preëxisting pathology, present at the time of the first operation, such as a small stone in the hepatic or common duct, or in the later cases it may develop as the consequence of choledochitis, cholangitis, chronic pancreatitis, adhesions, or stricture of the common duct.

Since the principle of removal of a diseased gall-bladder when possible,

has been substituted for drainage of the gall-bladder, the number of cases requiring secondary intervention has diminished twenty-five per cent.

How can we explain this persistence of symptoms after the gall-bladder which showed definite lesions has been removed? One cause may be visceroptosis. We therefore make it a practice to rule out ptosis by the X-ray before the first operation, and if present, correct it by posture and support after the operation. In overlooking visceroptosis repeated operations may be resorted to without improvement and the patient's condition may become steadily more distressing.

Adhesions.—After surgery of the gall-bladder and the biliary tract, adhesions to the hepatic and common ducts, the liver, the duodenum, or the hepatic flexure, are found in more than fifty per cent. of secondary operations. They form as the result of infection, trauma, hemorrhage, congestion and stasis, and unprotected raw peritoneal surfaces. Nowhere in the abdomen should the surgeon handle the tissues more " lovingly " as Crile puts it, than in the right upper quadrant. I have frequently been confronted with such a mass of adhesions that it was all but impossible to find the usual landmarks. The stomach and duodenum may be so matted together with the hepatic flexure of the colon and the great omentum and the whole so fused to the under-surface of the liver that, only with the utmost patience and determination can the situation be solved and the common duct exposed to view. In certain of these cases I make a gastro-enterostomy in the hope of avoiding obstruction in the future. Stricture of the common duct may be due to extraductal adhesions, or to intraductal scar formation due to the presence or the passage of a stone. Occasionally spasticity of the musculature of the biliary tract and the duodenum, part of a neurasthenic constitution touched off by disease of the biliary tract, may give rise to a situation difficult to correct by any measures known to the surgeon.

In my opinion infection of the gall-bladder also indicates a certain degree of infection in the liver, and very frequently the main ducts are included in the picture. Removal of the gall-bladder may eliminate enough of the pathology to enable the cellular and hæmatogenous regenerative forces of the body to overcome the smouldering process in the liver and its main channels. Since chronic biliary tract disease may give rise to a low-grade catarrhal gastritis with subacidity or anacidity, and since removal of a diseased gall-bladder does not always influence the condition in the stomach, and as we all know, a low acidity favors bacterial growth, it is possible that this is another cause of re-infection.

Secondary operations may be required for chronic pancreatitis, especially when the head of the pancreas is enlarged and sclerotic, due to a descending infection from the biliary tract by way of the lymph channels. Stasis of bile in the common duct increases stasis in the pancreatic duct, and stasis of the pancreatic secretion in turn plays a rôle in the development of pancreatitis. Observations in our Follow-up Clinic show that patients suffering

from cholecystitis with an associated hardness of the head of the pancreas at the time of operation, do not recover health so promptly as those in which cholecystic disease alone was found. Pain seems to persist and the stools show an increase in the neutral fat and fatty acids as well as undigested protein fibres. Diastase is present in the urine and lipase in the blood serum. Thus we have another important cause of persistence of symptoms following operation for gall-bladder disease calling for secondary operation. Where there is cicatricial or spasmodic contraction of the papilla of Vater the condition is intensified, and the procedure at re-operation consists of dilatation of the papilla and drainage of the common duct by means of a T-tube. If the gall-bladder has not previously been removed, a cholecystoduodenostomy may be done, although I believe external drainage is the better procedure.

Occasionally fistula develops after operation on the biliary tract. After cholecystectomy this may be due to an overlooked stone in the common duct and slipping or premature absorption of the ligature on the cystic duct. After cholecystostomy it may be the result of a stone in the common duct or of calculous or inflammatory obstruction of the cystic duct. Injury to the common duct or the duodenum also may cause a biliary fistula. In a certain percentage of biliary fistulæ, drainage from the duodenum into the fistulous tract may occur. These are serious and difficult to treat as the powerful digestive enzymes rapidly affect the surrounding tissues.

Peptic Ulcer.—As a rule, operation for peptic ulcer brings about a cure, or at least marked relief, but in a small percentage of cases post-operative symptoms are sufficiently pronounced as to require exploration to determine the cause of the trouble. Operation may reveal merely adhesions, or disease of an adjacent viscus—the gall-bladder, liver, pancreas, or appendix—may be found. Or the symptoms may be due to a functional disorder arising in the vegetative nervous system, of which we know so little. Sometimes the blame can be laid on the enterostomy stoma, which being too small interferes with proper emptying of the stomach contents, or if too large predisposes to regurgitation of bile and intestinal secretion and gastric contents, thus producing the burning sensation and gaseous eructations for the relief of which the patient once more presents himself to the surgeon. There is, however, one group of patients who may be symptom-free for many months and then experience the old "burning, gnawing distress in the epigastrium," that leads to the suspicion of the presence of another ulcer or a marginal ulcer.

Vicious circle, or as Peterson better describes it, "gastric ileus" since anterior gastro-jejunostomy has been replaced by posterior anastomosis, may occur in four different ways: from the back-flow of duodenal contents through an open pylorus; regurgitation through the proximal loop; the gastric contents may move into the proximal instead of the distal loop, and then be regurgitated through the pyloric opening; lastly, back-flow from the distal jejunal loop. From our X-ray studies of the function of the gastro-jejunal

stoma, we find that in the same patient, the food sometimes passes through the new opening and sometimes through the pylorus, so that a percentage of cases are seen in whom the symptoms apparently subside when the gastro-jejunostomy is closed, the pylorus not having been materially altered surgically. With the ptotic type of stomach, gastro-enterostomy is not always successful and recurrence of symptoms is apt to follow after operation. Sometimes also a normally situated stomach may tend to sag when the jejunum is joined to it, if the lesser omentum is too elastic. In a word, the greater the pathologic changes at the first operation, the safer is the gastro-enterostomy as regards later functional disturbances.

Marginal Ulcer.—Gastro-jejunostomy is not a cure-all for peptic ulcer; nor is subtotal gastrectomy; nor is pyloroplasty. I have seen ulcers recur following each of these procedures. The general impression, as I interpret it, is that marginal ulcers occur more frequently following gastro-jejunostomy than after gastric resection. Statistics are extremely variable. In a series of two hundred and forty-seven cases operated in the Lankenau Clinic, there were fifty-three gastric ulcers, one hundred and seventy-four duodenal ulcers, and twenty marginal ulcers. Our records show four recurrent ulcers after gastric ulcer, seven marginal ulcers following duodenal ulcers (4.5 per cent.), while in eleven (operated elsewhere) it was impossible to ascertain the type of ulcer originally present. The shortest time between operation for ulcer (duodenal) and marginal ulcer was one year and five months—the longest time fourteen years (the first operation having been performed for a perforated gastric ulcer at which time a posterior gastro-enterostomy had been done).

Marginal ulcer is a very real surgical entity. So long as gastro-jejunostomy is performed we subject the patient to the risk of this recurrent ulcer. Haberer believes it occurs more frequently after posterior gastro-jejunostomy with a short loop, and therefore advocates subtotal gastrectomy for all cases of peptic ulcer. But he also has seen marginal ulcer develop after the radical operation. Marginal ulcers, as we all know also perforate. Since they are distant from the solid viscera, the perforation permits the free discharge of gastric contents into the peritoneal cavity, which, when the ulceration involves the colon, produces a gastro-jejuno-colic fistula. We have recently had three such instances.

Some of the possible factors in the causation of marginal ulcer are infection, improper suture, mechanical injury, circular spasm of the gastric or duodenal musculature, retrograde discharge of the jejunum into the stomach; failure of neutralization of the gastric juice by the duodenal fluid and the action of the hydrochloric acid on the jejunal mucosa. We agree with Reimann as to the importance of two factors: first, injury to the mucosa, and secondly, the eroding, digestive action of the gastric juice. Symptomatically, as a rule, there is pain either in the epigastrium or the hypogastrium, or a gastric hemorrhage may be the first evidence of the trouble. X-ray may

or may not be of value in diagnosis while analysis of gastric contents is of little utility in these cases. The diagnosis is made principally on the history of typical pain, confirmed when possible by röntgenologic studies. In the light of our present knowledge the question naturally arises what measures taken at the primary operation will minimize the possibility for marginal ulcer to develop? As already stated, I believe the principal factors in its causation are injury followed by the digestive action of gastric juice, acting at the line of suture. Therefore the guiding principle is, as little trauma as possible, control of minute bleeding, handling tissues with rubber-tipped forceps, absence of traction, etc. In addition to this, let me state that in no realm of medicine is coöperation between the internist and the surgeon more important than in the after-care of peptic ulcer cases. The proper kind and amount of food, and holding the patient to this strict diet over a considerable period of time are absolutely essential. Administration of alkalies is also desirable for those patients who have gaseous eructations, belching, and mild distress. The operation is but one phase in the treatment of these cases. Disregard of the other features in treating them may lead to unpleasant complications.

From what we know about peptic ulcer and because of a certain degree of uncertainty as to the results obtained by secondary surgery, I advise dietary regulation and medical treatment in selected cases in whom the symptoms arouse the suspicion of secondary ulcer. I have referred many of these patients to my medical colleagues and have seen complete relief of symptoms in a number of instances; at any rate, if operation is advised later on, the patient is in better condition for it. One cannot be dogmatic. Success lies in individualization of each case. Prolonged medical treatment with no relief is as bad a practice as immediate operation on every case. For gastric ulcer the consensus of experienced surgical opinion favors surgery in every case because of its ominous possibilities, but duodenal ulcer is a problem which the internist and surgeon should solve together. As C. H. Mayo aptly states: "For the good of the patient there should be harmony of consultation, discussion and decision as to the method of treatment . . ."

Inguinal Hernia.—Recurrence following inguinal herniorrhaphy is another major problem with which the surgeon of to-day has to deal. Recently a patient operated one year previously for inguinal hernia returned to our Follow-up Clinic with a recurrence of the hernia. He desired to know whether following another operation the probability of recurrence would be greater, the same, or less than existed after the first operation. We replied that our statistics indicate that recurrence after a second operation for hernia took place in approximately five per cent. of cases. Statistics of different clinics vary greatly in the percentage of recurrences following inguinal herniorrhaphy. In the last five years nine hundred and twenty-six cases were operated in the Lankenau Clinic for inguinal hernia, of these one hundred and two (11 per cent.) were recurrent cases. In the last sixty cases fifty-four

occurred in males, six in females and forty-two of the sixty had been operated elsewhere for the primary operation. The division between right and left inguinal hernia was approximately equal.

Recurrence of an inguinal hernia following operation depends on several factors: (1) type of hernia, (2) degree of hernia, (3) substantiability of involved structures, congenital predisposition, and age of patient, (4) type of primary operation (including type of anæsthesia and suture materials used), (5) infection at primary operation, (6) after-care—daily routine following release from hospital.

Direct herniæ are found in about five per cent. of all inguinal herniæ, and they recur more frequently than the indirect type because "buffer tissues" to the intra-abdominal force are more difficult to secure and retain in place. Coley states that recurrence in ninety per cent. of cases takes place within the first year, and furthermore, if the tissues hold firm for a year they will probably remain so.

The size of the primary hernial sac gives a certain clue to prognosis: for the larger the sac, the wider and more loose the tissues surrounding the internal ring, the more likely is recurrence to take place since the "stage is set."

An important factor in recurrence is the stability of the anatomic structures in the region of the rings and the inguinal canal. Each exit from the abdomen through the abdominal wall represents a potential hernia. Many surgeons believe certain individuals exhibit a predisposition to hernia. This may be explained by the tissues which give way, the age of the patient (to a minor degree) and his work, together with such factors as continued increase in intra-abdominal pressure from constipation, heavy lifting, etc. Continued pressure from a truss-pad causes atrophy and fatty degeneration of muscle fibres, a condition which may also exist in elderly patients without the presence of a truss. A patient whose musculature elsewhere is well developed may possess yielding fibres in the inguinal region. Anatomic variations probably also account for a certain number of recurrences. Bloodgood and Hessert, independently, have called attention to cases in which the conjoined tendon was either attenuated or absent, an important condition in the development and recurrence of direct hernia, since the lower angle of the canal is thus deprived of its strongest support. Hessert in these cases has noted developmental defects of the external oblique fascia with an abnormally large external ring. The absence of the conjoined tendon, according to a report by Taylor, accounts for thirty-seven and one-half per cent. of recurrences.

With the proper repair of the primary hernia the possibility of recurrence is of course reduced to a minimum. By proper repair we mean knowledge of the forces which produced the sac, an appreciation of the weakness of the anatomic structures which are sometimes included, and too greatly relied upon in making the repair, the selection of proper suture materials, and the absence of infection. The parts should be restored as nearly as possible to

the normal. The disposition of the cord is of no especial importance so long as its function is not impaired. The sac is freed, the peritoneum separated for some distance at the site of the internal ring, by blunt dissection, put on tension, tied off as high up as possible, and then cut off. Some operators advocate anchoring the stump to the overlying muscle, displacing it, and furnishing a sufficient buffer against which the intra-abdominal force is exerted but which it, presumably, cannot overcome. Scarification may favor the formation of supporting adhesions between the stump and the muscle fibres.

The success of herniorrhaphy depends on the formation of a permanent cicatricial union between the structures in this region. Since many experiments apparently prove that tendon and muscle will not unite, whereas union of tendon to tendon is more trustworthy, many surgeons have used autoplastic suture materials in the repair. Opinions differ as to the durability of these bands and in repeated instances they have become absorbed. I often use the Andrews' method of suturing tendon surfaces, thereby following the principle that surfaces hold while edges frequently separate; sometimes I create an aponeurotic canal for the cord, utilizing the tendonous flaps of the aponeurosis of the external oblique. The procedure of suturing muscle fibres of the internal oblique and transversalis muscles to the shelving margin of Poupart's ligament is of doubtful value, for with the absorption of the suture these structures may promptly separate.

Formerly infection of the wound at, or following operation was an important feature in the histories of recurrent herniæ. Improved technic, however, is minimizing this feature.

To my mind proper after-treatment is just as essential to a happy result as is the proper selection of the operation. Our patients are required to lie quietly in bed for fourteen days with the scrotum supported. Many surgeons advocate as long as three weeks of rest. Patients should be informed that recurrence may result from any sudden strain, such as lifting oneself in bed, repeated strain at stool, getting out of bed too soon, etc.

Convalescence must be very gradual and we have found the use of an elastic support to the lower abdomen of real value. Heavy lifting, horse-back riding, tennis and like pursuits should be abandoned for some time. On the other hand, graded exercises are necessary for the general well-being of the patient. The two principle features in the proper disposition of an inguinal hernia are high ligation of the sac and proper after-care.

A survey of cases subjected to operation a second time impresses upon me the tremendous importance of a painstaking, thorough study of each case before the primary operation is performed. We owe the patient the benefit of all necessary accessory clinical and laboratory tests, no matter how small, that may add to our security in diagnosis. Selection of the proper time for surgery and the best type of anæsthesia is important. At operation an exhaustive search for additional factors as, for example, the existence of a diverticulum in the wall of a urinary bladder opened for removal of an

enlarged prostate gland, should always be made, otherwise the patient will continue to be distressed and a second operation will be necessary. Respect for tissues at all times, thoughtful and considerate post-operative medication and care, and a sustained interest in the patient carried out systematically by a Follow-up Service will diminish the number of secondary operations entered on hospital records. In the majority of the cases requiring repeated intervention someone is to blame. I have tried to show you the rôle the surgeon plays and to point out the pitfalls in his path; the other responsible party is the patient himself. By modern methods of publicity the laity are becoming educated in the symptomatology of the more common surgical diseases and patients are therefore more prompt in seeking professional care. Those who fail to do so increase their own risk and add to surgical morbidity and mortality.

VALUE OF RADIOGRAPHIC CONTRAST SOLUTIONS IN THE STUDY OF BRAIN ABSCESS*

By Eugene W. Rockey, M.D.
of Portland, Oregon

Brain abscess cases present many problems in treatment, not the least of which is the post-operative course after the original drainage has been instituted. A knowledge of the size, shape, and accurate location of the abscess cavity is of decided value. The only practical method by which

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Fig. 1.—Radiograph before any operative procedure. Note rarification in parietal region.
Fig. 2.—Antero-posterior view before operation; not diagnostic.

this knowledge can be acquired is by radiographic study after the injection of the cavity with a contrast solution.

Lipiodol, which is a 40 per cent. iodine solution in poppy seed oil, the use of which was first advocated by Sicard† of Paris in 1921, has probably been the most extensively used contrast solution in neurological studies. It is insoluble, and remains in any closed cavity as a foreign body. That it may cause irritation, and perhaps serious consequences, has been pointed out by William Sharpe.‡ The leaving of any foreign body in the presence of infection would be doubly dangerous, and therefore to be avoided. A solution of sodium iodide is very soluble, and is rapidly absorbed. It furnishes an

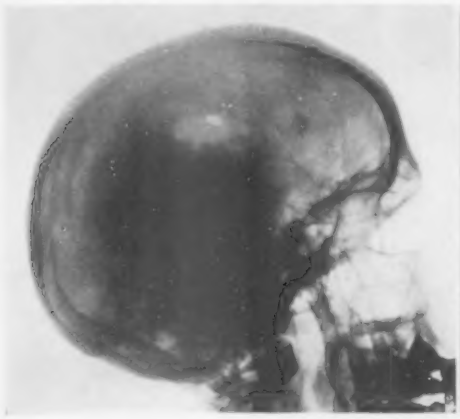
* Read before the Tri-County Medical Society at Salem, Oregon, February 15, 1927. Preliminary report of this study read before the North Pacific Surgical Association, Vancouver, B. C., December 10, 1926.

† Sicard, J. A., et Forestier: Rev. Neurol., 1921, vol. vi, p. 1264.

‡ Sharpe, W., and Peterson, C. A.: Annals of Surgery, vol. lxxxiii, p. 32, January, 1926.

excellent contrast medium, and if injected without undue pressure in a cavity does not cause irritation. This does not refer to the thecal cavity.

In making the present study a 20 per cent. sodium iodide aqueous solution



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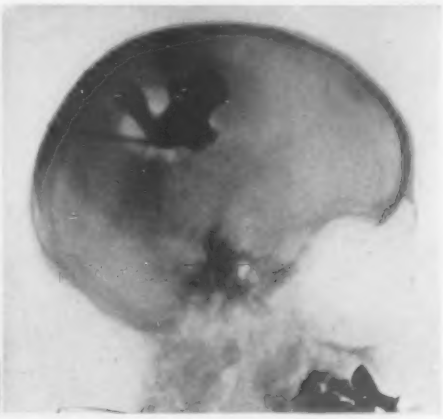

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FIG. 3.—Radiograph after the bone had been removed, exposing extra-dural abscess.
FIG. 4.—Lateral view one week after drainage of brain abscess. Cavity injected with sodium iodide solution.

was used. The results were so satisfactory and instructive that the procedure and findings seem to warrant a report. A search of the literature has failed to disclose the previous use of this method.

CASE.—A man, fifty-nine years old, referred by Dr. Harvey Parker. General health always very good. No paralysis. No mental impairment. When three years of age he sustained a compound fracture of the skull in the left parietal region. Since then

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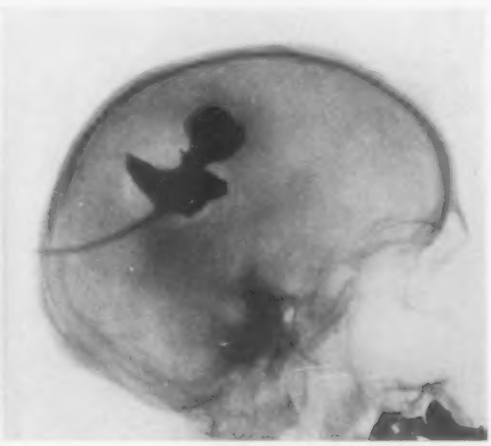

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FIG. 5.—Antero-posterior view one week after drainage of brain abscess. Cavity injected with sodium iodide solution.
FIG. 6.—Lateral view of brain abscess cavity, injected with sodium iodide solution. This eleven days after previous radiograph. Comparison of this radiograph with Fig. 4 will show the diminution in size and change in shape of the cavity.

the scalp had always been tightly adherent to the skull in this region. Ten years ago the scalp had so thinned that a small point of bone projected through the skin. The thinned-out scalp was excised under local anæsthesia, the projecting bone was chiselled

off, and a skin graft applied. In a like manner projecting points of bone were removed six and again five years ago.

In October, 1925, a small area of scalp in the left posterior parietal region developed

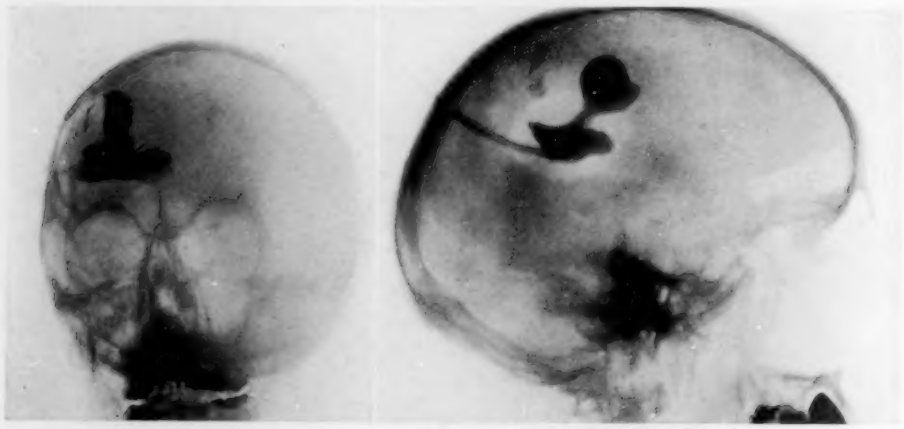

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FIG. 7.—Antero-posterior view eleven days after radiograph, Fig. 5. Comparison with this shows the diminution in size and change in shape of the cavity.

FIG. 8.—Lateral view seven days after radiograph, Fig. 6. Note farther diminution in size, and marked pinching off of upper cavity, leaving it connected by a narrow sinus.

a slightly raised-edged ulcer. This was diagnosed as an epithelioma, and was given one application of radium in November, 1925. No farther radium treatments were given. The healing was very slow, and was not complete until August, 1926.

In September, 1926, an area of scalp, 1½ x 1 inches in size, located half an inch in front of the area which had been treated with radium, became black and necrotic.

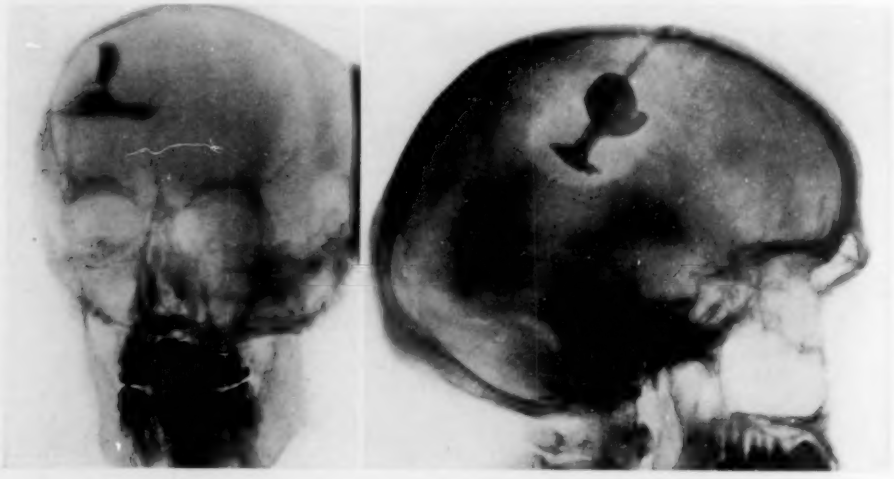

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FIG. 9.—Antero-posterior view seven days after radiograph, Fig. 7. The pinching off of the upper cavity is definitely to be noted here.

FIG. 10.—Lateral view seven days after radiograph, Fig. 8. Note the marked closing in of the lower portion of the cavity with little change in the upper portion.

Doctor Parker, under whose observation he was at this time, expressed the opinion that this seemed to be an area of gangrene due to thrombosis of the vessels of the scalp. When this necrotic scalp came off the latter part of September, 1926, he had an intense

headache lasting two or three days. For the next three weeks he felt sick, and ran a fever, and had a moderately severe headache.

Examination October 22, 1926. A sick looking man. Temperature 102.5°. Pulse 90.

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FIG. 11.—Antero-posterior view seven days after radiograph, Fig. 9. Note the decrease in size of the lower portion of the cavity without change in the upper portion.

FIG. 12.—Lateral view nine days after radiographs, Figs. 10 and 11. Very little sodium iodide could be injected. However, when this is compared with the previous radiograph it will be seen that some entered the upper cavity.

Local examination showed an area of bare, whitened skull, 1½ x 1 inches, in the left parietal region. The scalp for an inch in all directions, and two inches below the exposed area of skull, was red and swollen, evidently acutely inflamed.

He was put to bed, and massive hot, wet dressings of a saturated solution of boric

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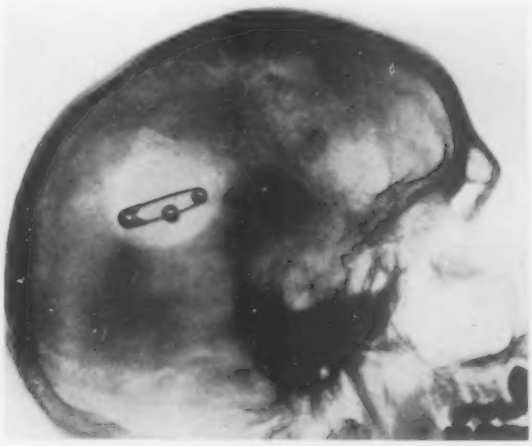

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FIG. 13.—Antero-posterior view nine days after radiographs, Figs. 10 and 11. See note on Fig. 12. The picture taken with the head turned on the side. The definite fluid level of the sodium iodide, which entered the upper cavity, can easily be seen with the gas above it.

FIG. 14.—Lateral view without any sodium iodide injection. This and the following plate were made twenty-eight days after radiographs, Figs. 12 and 13, and after the patient had had an exacerbation of his old symptoms.

acid applied. In two days his headache had gone, and in four days his temperature had dropped to normal. He was allowed to be up and about. A few days later a

small abscess developed in the scalp just posterior to the denuded area. This was opened, and drained pus freely. He felt much better. His temperature remained normal. X-rays, see Figs. 1 and 2, showed an area of rarification roughly corresponding

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FIG. 15.—Antero-posterior view without any sodium iodide injection. This and the preceding plate were made twenty-eight days after radiographs, Figs. 12 and 13, and after the patient had had an exacerbation of his old symptoms.

FIG. 16.—Lateral view four days after radiographs, Figs. 14 and 15. In the meanwhile the upper abscess cavity had been drained through a separate incision, and the present tube runs through the upper of the two openings. Sodium iodide injection.

to the denuded skull. Pus continued to drain very freely from the small scalp incision, so much so that we concluded that it must come from an abscess between the tables of the skull, or just within the skull.

November 5 he had a slight headache, and his temperature was 101.6°. There was no

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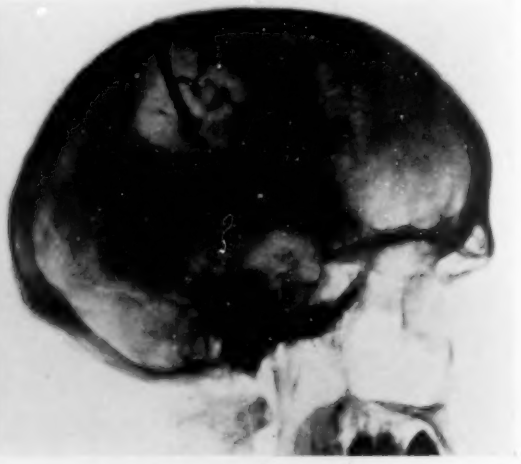

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FIG. 17.—Antero-posterior view four days after radiographs, Figs. 14 and 15. In the meanwhile the upper abscess cavity had been drained through a separate incision, and the present tube runs through the upper of the two openings. Note that none of the sodium iodide ran downward into the lower cavity.

FIG. 18.—Lateral view made immediately following the two preceding radiographs. In this case the tube has been introduced through the lower of the two openings, and some of the contrast solution still remains in the upper cavity.

paralysis, nor change in reflexes. He was sent to the hospital to be operated upon the following morning.

At 5 A.M., November 6, he awakened, and was unable to speak distinctly, and had difficulty in using his right hand and right leg, although he could move them. Four hours later under local anæsthesia an opening was made with a Hudson drill through the exposed bone. This entered an extra-dural, granulation lined, abscess cavity containing about 5 c.c. of creamy pus. In this pus there was a small loose piece of necrotic bone. The bony opening was enlarged with rongeurs to the limits of the cavity. There was no bulging of the dura, which pulsated normally. Smears and culture showed a non-hæmolytic streptococcus, not streptococcus viridans.

The granulation-covered dura, which was left fully exposed, continued to pulsate freely. His general condition improved, and for two days his speech was normal, and he was able to use his right hand almost normally.

November 12 he became rapidly worse, was unable to talk, and his right arm and leg became completely paralyzed. X-ray, see Fig. 3, was of little help. In the afternoon he became unconscious. His pulse was 90; temperature 100.4°. Eye grounds normal. There was no bulging of the dura.

November 13. In the early morning he was deeper in his unconsciousness. Pulse 108, and axillary 101.6°.

It was decided that there must be a deep brain abscess, in spite of the freely pulsating and retracted dura. At 10 A.M. a needle was introduced, pointed slightly upward and forward. At a depth of one inch 2 c.c. of slightly cloudy, yellowish fluid was obtained.

FIG. 19.—Antero-posterior view made immediately following radiographs, Figs. 16 and 17. In this case the tube has been introduced through the lower of the two openings, and some of the contrast solution still remains in the upper cavity.

By 8 P.M. his condition was much worse. Pulse 120. Axillary temperature 102.8°. Respirations Cheyne-Stokes in character. Again a needle was passed through the same dural opening, this time directed horizontally and slightly backward. At a depth of 5/8 inch cloudy amber fluid was obtained, and after 1 c.c. had run out thick creamy pus came. A 3/16 inch diameter rubber tube was now introduced into the abscess cavity.

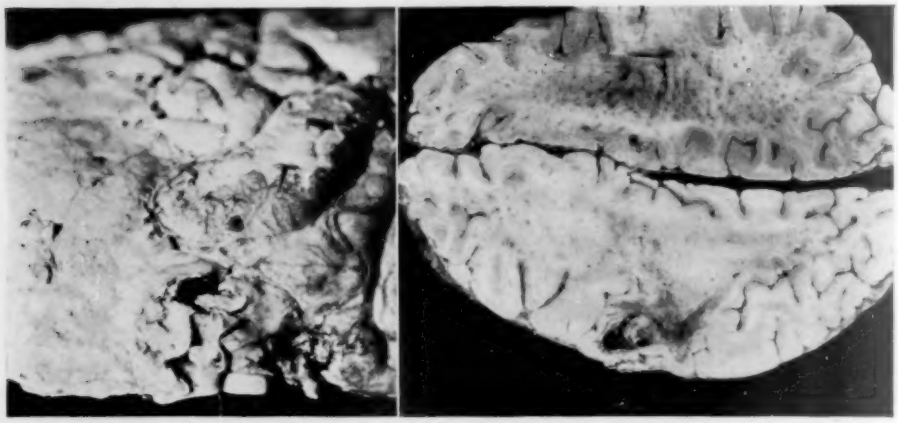
His general condition improved markedly, and by the following morning he was conscious. Aphasia was still complete.

November 20, one week following the drainage of his brain abscess, it was decided to make a contrast solution study of the abscess cavity. This was done by injecting a 20 per cent. aqueous solution of sodium iodide through a tube of similar size to the drainage tube, which was removed for the purpose. The injection and subsequent radiographs were made with his head turned on the side, so that the fluid would not run out. The injection was made with a syringe, but care was used to exert no undue pressure. Twelve c.c. entered the cavity. X-rays, Figs. 4 and 5, were made. The information thus obtained was of great value.

Neither at this time, nor with any of the following injections, were any untoward symptoms noted as the result of the sodium iodide injections.

Improvement was fairly constant from the time of the drainage of the abscess November 13 until January 22, 1927. November 21 there was pain in his right leg. November 24 motion returned in the right leg. December 1, see X-rays, Figs. 6 and 7, by this time he was able to say simple things, partial phrases. December 4, there was

pain in the right hand and arm. He was up each day in a wheel chair. December 8, there was slight motion in the right index finger. His temperature had been normal for a week. He was clear mentally. He could speak at times whole sentences, although at



20 21

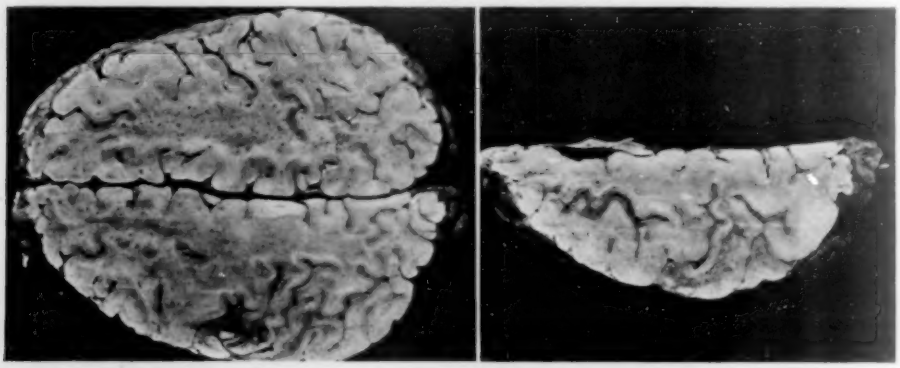
FIG. 20.—Close-up view of outside of brain, showing the two drainage holes, and showing the plastic exudate on the meninges.

FIG. 21.—Section through brain at level of abscess cavity. The hole made by the drainage tube is open, but there is no abscess cavity as such. Careful inspection will show the location of the arm of the cavity, which ran backward and inward.

other times his aphasia was still marked. See X-rays, Figs. 8 and 9, showing a continued decrease in size of the cavity.

It is to be noted that the upper arm of the cavity was being narrowed down very rapidly in the form of a pedicle, leaving a bulbous area above it. At this time a preliminary report of this case was read, and the following statement was made. "A continuation of these X-ray studies will be made, and should the healing pinch off the upper arm, leaving an isolated, undrained abscess, it will be of great value to know just where this is, so it can be reached with the minimum of trauma."

Figures 10 and 11 show a marked closing in the lower portion of the cavity without



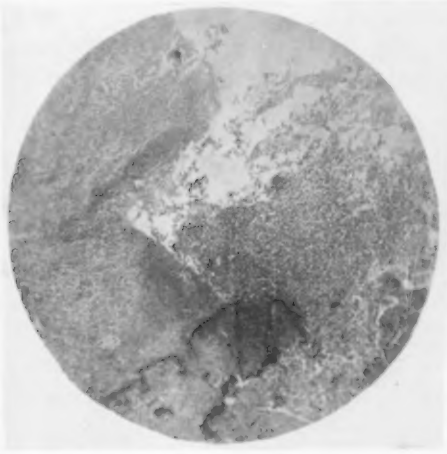
22 23

FIG. 22.—Section of brain at one-quarter inch higher level than preceding section. Note how healing of the abscess cavities has taken place.

FIG. 23.—Section of brain at one-quarter inch higher level than preceding section. Again note the healing of the abscess cavities.

change in the upper portion. Figures 9 and 10 show that the lower portion had closed in to a minute sinus, but that the upper portion, or cavity, still remained. Little sodium iodide entered.

Clinical improvement was marked. He was able to be up, and walk about. He was entirely clear mentally. Motion had returned in the right hand, so that he could flex and extend all of the fingers, and thumb, and supinate and pronate the forearm,



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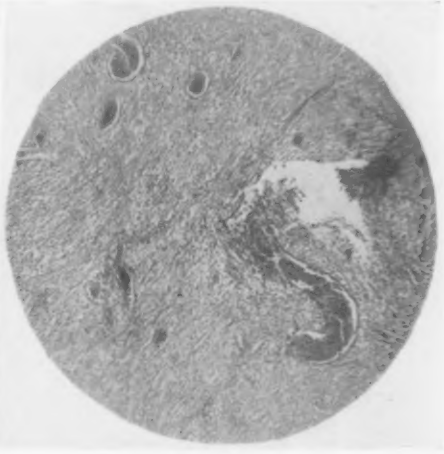

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FIG. 24.—Abscess wall reveals extensive diffusion of red blood-cells and polymorphonuclear neutrophilic infiltration.

FIG. 25.—Dilated vessels in immediate wall of abscess, also inflammatory cell reaction.

but he was not able to make finer motions. His aphasia had become much less marked, and he was able to make himself fully understood, and at times he could speak quite distinctly. The drainage tube was kept in place all this period of time, but gradually shortened during the week preceding January 22. On the morning of the 22nd it was found in the dressing, and no attempt was made to replace it. There had been very little drainage for this past week.

On the afternoon of January 22 he became very irritable, and complained of headache. By the following afternoon his temperature had risen to 102.8°. The paralysis had again become complete in the right arm and right leg. There were definite twitchings in all extremities. The neck was not stiff, and the legs could be freely extended when the thighs were flexed on the body. The drainage tube was re-introduced into the sinus, but no accumulation of pus found. A needle was introduced through a newly made opening in the exposed dura at a point that was apparently directly over the upper pinched-off abscess cavity as shown in the radiographs. However, no pus was found. He seemed better for two days, and then became unconscious with Cheyne-Stokes respiration. There was still no rigidity of the neck, and Kernig's sign was absent. Again a large needle was introduced through the recently made opening in the dura, and this time at a depth of ¼ inch an abscess cavity was entered, and creamy pus evacuated. A drainage tube was introduced.

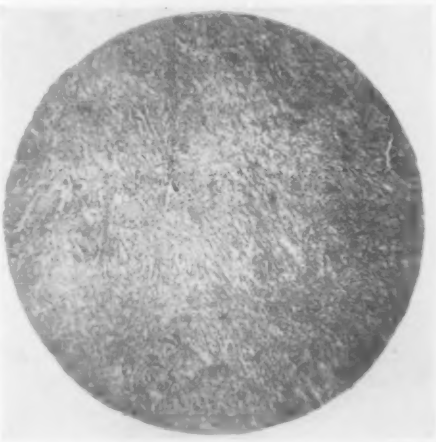

FIG. 26.—Shading of inflammatory process from abscess wall into brain tissue.

In Figs. 16 and 17 we see the sodium iodide solution introduced through the newly made opening into the upper cavity. Note that none of the sodium iodide solution runs downward toward the old drainage tract. Figures 18 and 19 show the injection made into the lower cavity immediately after the previous injection had been made. Some of the iodide solution still remained in the upper cavity.

He became progressively worse, temperature, pulse, and respiration gradually rising until death. At no time was there rigidity of the neck, nor a positive Kernig's sign. Blood culture was negative.

Autopsy done by Dr. C. H. Manlove disclosed a meningitis which had evidently involved the left parietal region for a period of some days (see Fig. 20), and then become generalized. This was the cause of death.

Sections through the brain showed that the abscess cavities were well drained, and that there had been no great destruction of brain tissue, see Figs. 21, 22, and 23. Microscopic sections, see Figs. 24, 25, and 26, show distinct organization and repair with a thin abscess cavity wall.

Comment.—The possibilities of the value of sodium iodide radiographs of a brain abscess are well exemplified here. We are able definitely to know the location, size, and shape of the abscess cavity, and to study the manner in which healing takes place. Also in addition to the value in the individual case, similar studies of other brain abscesses may add to our knowledge of this subject.

A METHOD OF REMOVING DISCRETE ADENOMATA OF THE THYROID

By Frank H. Lahey, M.D.
of Boston, Mass.

The removal of discrete adenomata of the thyroid is technically the simplest and safest procedure of all the operative procedures performed upon the thyroid gland. One deals only with a definitely encapsulated tumor in a patient usually devoid of marked toxicity and as a rule in good general condition. Mortality of operative removal in 1093 patients with discrete adenomata of thyroid in our hands has been fifty-six hundredths of one per cent. This mortality rate covers all types of discrete adenomata of thyroid at all ages, those with congestive heart failure and those of intrathoracic location. It is evident, therefore, that operative risk of removals of this type of goitre is not great.

Fig. 1.—This was the plan employed for several years in removing discrete adenomata of the thyroid. Its disadvantage is the amount of bleeding which follows blunt separation of the adenoma from thyroid tissue and the fact that the small vessels which run from the thyroid to the adenoma when torn retract into the posterior shell of the thyroid tissue so that they are difficult to catch without pushing the points of the hæmostats well down into the posterior shell of thyroid tissue.

The gravest danger in this type of goitre, in our experience, has been that of injury to the recurrent laryngeal nerve and injury to the inferior parathyroid body on the operative side.

Discrete adenomata of the thyroid are almost always located on one or both lobes of the thyroid. Occasionally they do arise in the isthmus and remain located in the middle line, but due to the median prominence of the semi-rigid trachea, together with the counter-pressure of the perithyroid muscles, even though they arise in the portion of the thyroid which is at or close to the median line, they tend as they increase in size always to be guided eventually into a lateral position on either lobe beside the trachea.

As the adenomata increase in size, they gradually encroach upon the substance of the lobe, particularly as relates to the body of the lobe, until as enlargement of the adenoma goes on, an increasingly thinner layer of thyroid

tissue covers the posterior aspect of the discrete adenoma. (The thin layer of thyroid tissue may be noted in Fig. 3.)

It is because of the thinness of this layer of thyroid tissue covering the posterior aspect of the adenoma of the thyroid that the recurrent laryngeal nerve and the inferior parathyroid are so commonly injured in the removal of discrete adenomata. As the adenoma is shelled out and separated from this covering of true thyroid tissue, numerous small vessels are torn together with two or three fairly large branches of the inferior thyroid. It is in the securing of those vessels that the hæmostats and sutures used to catch them not infrequently penetrate this thin layer of thyroid tissue and include the nerve or the blood supply of the inferior parathyroid in their grasp, resulting in laryngeal paralysis and loss of inferior parathyroid body on operated side.

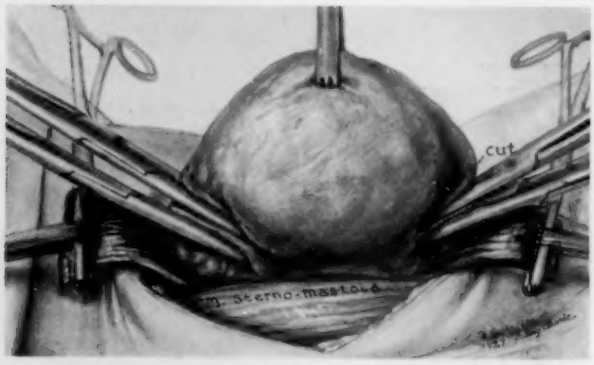

FIG. 2.—The application of Ochsner clamps above and below the adenoma. The clamps should be applied both above and below as close to the adenoma as is possible without including any of the capsule of the adenoma in their grasp. If this be done carefully, when the incision between the clamps and the adenoma is made the release of tension over the adenoma causes its capsule to bulge out prominently through the over laying layer of thyroid tissue. (See Fig. 3.)

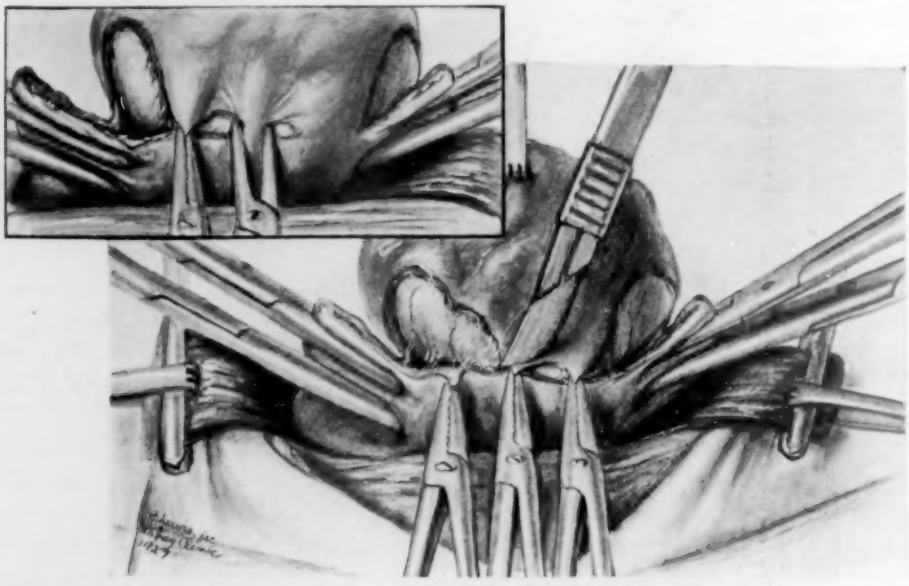

FIG. 3.—Incisions have been made above and below between the Ochsner clamps and the adenoma. The clamps have been applied so closely that when these incisions are made the walls of the adenoma bulge out through the thin layer of overlaying thyroid tissue. This drawing also shows the method of applying the two or three hæmostats so that they grasp only the thin layer of overlaying thyroid and the method of cutting away these bits of tissue, without injuring the capsule of the adenoma.

We have had this occur in our own experience, and have so frequently seen one-sided recurrent laryngeal paralysis following removal of a discrete adenoma elsewhere, that we are of the opinion that injury to the nerve is not an uncommon complication of removal of a large discrete adenoma of the thyroid occupying a large part of one of the thyroid lobes.

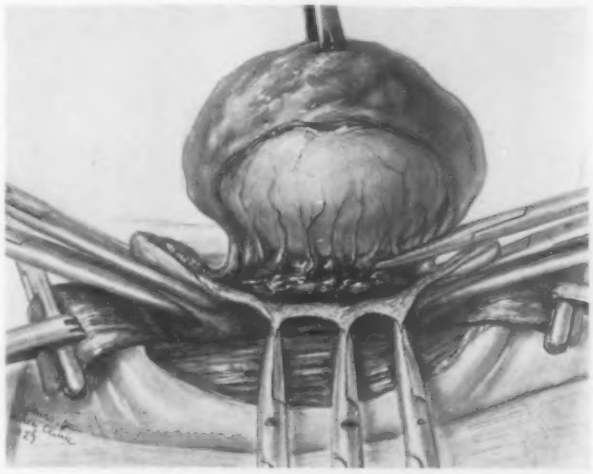

FIG. 4.—Showing the adenoma rotated inward to demonstrate the small vessels running from the posterior layer of thyroid tissue to the adenoma and the method of catching them in hæmostats while on the stretch.

Because of the danger of the above-described complications, we have gradually developed a technic for the removal of those discrete adenomata which now for some years has proven satisfactory in preventing such complications in the removal of these tumors. An Ochsner clamp is applied to the superior portion of the gland near the upper pole just outside that portion of the thyroid occupied by the adenoma. This procedure of clamping through the substance of the gland at the upper pole in discrete adenomata was first described by Halstead several years ago, and was the plan which we employed for several years. The finger was inserted between the fibrous capsule of the adenoma and the (Fig. 1) overlaying layer of thyroid tissue, gradually separating one layer from the other and clamping as the separation was continued. The disadvantage of this procedure was the amount of bleeding which resulted from the blunt separation of the adenoma from its bed of thyroid tissue.

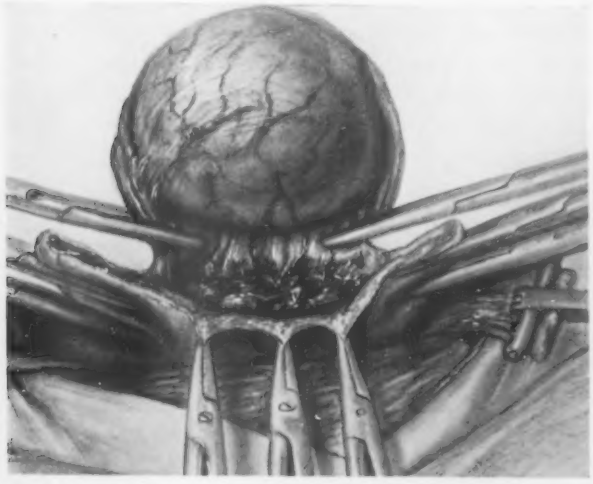

FIG. 5.—The adenoma has now been rotated well inward, so that it hangs only by the inner thin layer of thyroid tissue which covers the tumor. The vessels running between the adenoma and the posterior layer of thyroid tissue have been clamped and cut and the inner layer of thyroid tissue is being clamped preparatory to being cut away.

The application of an Ochsner clamp to the portion of the thyroid below

the adenoma and, similar to the Halstead procedure above the adenoma, was employed and the thyroid tissue caught in the grasp of the upper and lower clamps cut through with a knife. When this is done the adenoma is left attached only by its overlaying thyroid tissue at its most posterior aspect. (Fig. 2.)

Hæmostats are then made to delicately grasp the thin layer of thyroid over this portion of the adenoma fairly well up upon its lateral wall above the usual location of the inferior parathyroid, care being taken to be certain that the points of the hæmostats do not penetrate the fibrous capsule of the adenoma. (Fig. 3.)

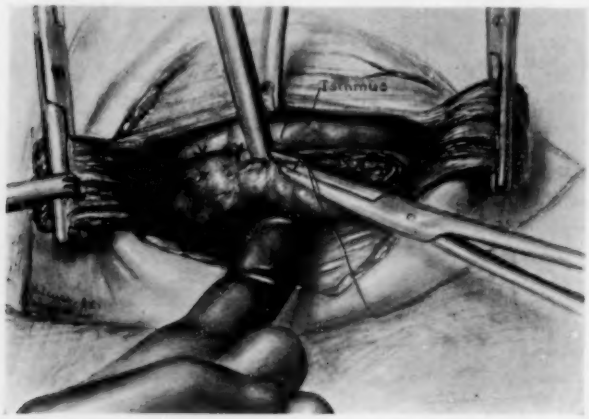

FIG. 6.—The upper and lower Ochsner clamps have been ligated and the external edge of the cut layer of thyroid tissue is being sutured to the inner cut edge to close the defect in the thyroid lobe.

If these clamps are properly applied and the true thyroid tissue in their grasps cut with a sharp knife without injury to the capsule of the adenoma, the entire layer of thyroid tissue overlaying the posterior aspect of the gland will be within their grasps, and by pulling outward upon the clamps and inward upon the adenoma, the vessels passing from the overlaying layer of thyroid tissue to the posterior surface of the adenoma may be caught with clamps and the entire thickness of the posterior layer of true thyroid tissue preserved. (Fig. 4.)

When all of the vessels passing from the posterior layer of thyroid tissue to the adenoma have been caught and cut, the adenoma will then be free except for the thin shell of thyroid tissue attached at the isthmus. This may be clamped with two or three hæmostats and the adenoma cut away. (Fig. 5.)

When the adenoma has been removed and the vessels tied, the median and external cut edges of the shell of thyroid tissue are united to close the defect in the thyroid. (Fig. 6.)

The technical plan here described has in our hands protected the recurrent laryngeal nerve and the inferior parathyroid body. It has lessened the amount of bleeding and has simplified the procedure of the removal of these discrete adenomata.

BILATERAL ATELECTASIS (MASSIVE COLLAPSE) OF LUNG

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and
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Sudden death during operation, with autopsy findings of massive collapse of the lungs, is the essence of the two cases we report.

That massive collapse of the lungs occurs has been recognized clinically and pathologically, as a review of the literature will show. That it has occurred as a sudden acute and tragic complication during operation, we have not hitherto found reported.

Case I.—A married white female, forty-four years of age, was admitted to the Second Surgical Division, Bellevue Hospital, September 21, 1926. She complained of pains in the lower abdomen and of a vaginal discharge. Both the above complaints had existed for six months preceding admission. Her father died of pernicious anæmia. Her mother, two sisters and one brother are living and well. She had been married twenty-three years, had two children, both living and well, aged twenty-two and seventeen, respectively. No history of miscarriages. Patient had always been well until six months before admission, when she noticed a feeling as of something falling down in the pelvis. This sensation was accentuated on exertion.

Examination showed a polypoid mass, about 3 x 3 x 2 cm., protruding from the vulva. It was red and bled easily. It was attached by a narrow pedicle to the anterior wall of the cervical canal, near the external os, which was large and patulous. The fundus of the uterus was large and detroverted. It seemed bound down to the hollow of the sacrum.

Heart and lungs were carefully examined and noted to be negative.

Pre-operative Diagnosis.—Fibromyomata of uterus.

September 24, the polypoid mass was excised, followed by supravaginal hysterectomy through a suprapubic incision.

Appendectomy was also performed.

Abdomen closed in layers.

As the last sutures of the abdominal wound were being tied, it was noticed that the patient had stopped breathing. All attempts at resuscitation, including artificial respiration, dilation of the sphincter ani, injection of adrenalin into the heart, the use of the pulmotor, etc., failed, and the patient was pronounced dead.

At Autopsy.—Left lung collapsed; right lung partially collapsed, moderately engorged; no food in bronchi; tongue natural. Fairly well-marked laryngeal œdema. The epiglottis was peculiar in shape; no obstruction by food.

Heart and abdominal organs normal.

Histological findings reported as follows by Doctors Symmers, Miles and McGrath.

Examination of microscopic preparations from the collapsed pulmonary lobes reveals a tissue which it is difficult to recognize as lung, resembling rather a solid organ. This appearance is found to be due to complete atelectasis of the pulmonary alveoli, the epithelial cells of which lie closely packed together, having lost entirely their normal alveolar arrangement. The individual cells are swollen, certain of them being obviously hydropic, and the cell outlines are rather indistinct.

The bronchioles are also collapsed for the most part, many of them being represented merely by circular clumps of cuboidal cells.

The capillaries, arterioles and venules, on the other hand, are all uniformly dilated and filled with blood, producing almost an angiomatous appearance in certain areas. This constitutes the most characteristic feature of the histology of the condition.

CASE II.—A man, age sixty-nine, was admitted March 12, 1926, to the Surgical Service of the Brooklyn Hospital.

Chief Complaint.—Pain and swelling in left abdomen.

For nine years he had suffered from slight abdominal pain. One and a half years before had sharp abdominal pain and passed bloody urine. November, 1925, began to get short of breath and thought upper left abdomen had been getting larger. Personal and family history negative.

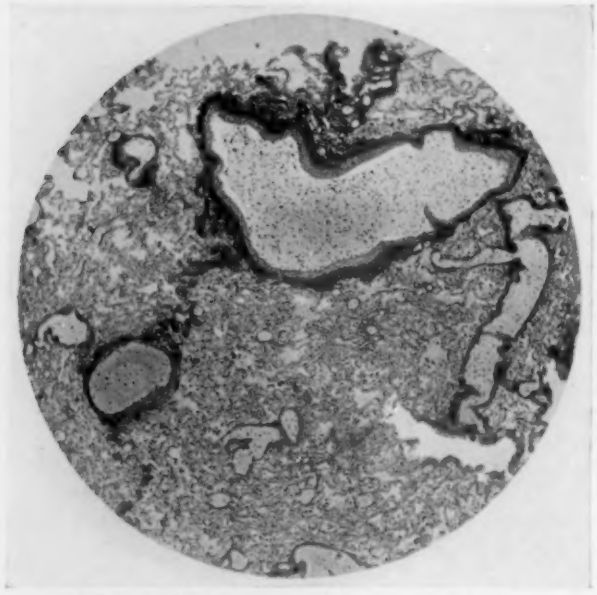

FIG. 1.—Photomicrograph, lung section, Case I.

Physical Examination.—Distended abdomen. Tumor mass in left abdomen, 6 inches below costal margin. Seems posterior; moves slightly with respiration.

Urine.—Faint trace of albumin; red blood-cells, 3,700,000; 63 per cent. hæmoglobin; white blood-cells, 2000; 40 per cent. lymphocytes; Wassermann negative; temperature, 99 to 101 degrees.

Clinical Diagnosis.—Banti's disease; kidney tumor; aleukæmic leukæmia?

Operation, March 19, 1926.—G. O. ether used. Duration of anæsthesia 65 minutes; one-half ounce ether used.

Operation.—Left rectus incision. Large spleen from crest of ilium to within two inches of midline. Very adherent and much trouble from oozing. Packs placed against liver. Wound closed. Saline clysis before end of operation and transfusion under way as operation ended. Patient apparently in shock, but improved under transfusion. Suddenly respiration stopped. Artificial respiration and stimulants without avail. Pulse perceptible at least ten minutes after respiration had ceased. Patient pronounced dead one hour after end of operation.

Autopsy.—One and one-half hours post-mortem. Peritoneal cavity contained about 50 c.c. free blood. Diaphragm at upper border of fourth ribs, both sides. No defect in diaphragm. No free pleural fluid. Serous surfaces smooth and glistening. Both lungs collapsed and lying close to vertebræ. They formed small, flat organs, each weighing about 50 gms. Only a small portion of each apex was crepitant. Rest of lung tissue firm and non-crepitant. On section the tissue was firm and homogeneous, pink in color. Pulmonary vessels empty. No secretion of bronchi. Heart weighed 300 gms.; contracted; otherwise negative.

Pulmonary atelectasis (massive collapse) has come to be recognized in recent years as a not uncommon complication after operations on the chest and abdomen, occurring rarely, if ever, after surgery confined to the extremities. The earlier work of W. Posteur in the first and second decades of this

century laid the foundation for its recognition as a definite clinical entity and stimulated the interest of others. The later writings of Elliot and Dingley, Bradford, Scrimger, Elwyn, Scott, Churchill, and others have served to arouse a fairly general interest among surgeons in this condition.

The occurrence of suddenly or rapidly developing respiratory distress, accompanied by cough, increased temperature, pulse and respiration, and at times by cyanosis, coming on from a few hours to a few days after operation, should lead the surgeon to look for atelectasis. The invariable physical sign of the condition is a displacement of the heart and the mediastinum toward the atelectatic lung. This can best be demonstrated by X-ray examination of the chest, though in most cases it is also demonstrable clinically. The signs over the affected lung vary greatly, depending on the extent and completeness of the collapse and the amount of moisture present in the lung.

While post-operative atelectasis has become well recognized as a clinical entity, the question of its etiology remains decidedly obscure. This may be due in part to the fact that the pathological data obtained to date is very meagre. It is a fairly benign surgical complication. Most of the cases improve very rapidly and recover completely, the number coming to necropsy being thus far very small. A number of theories have been advanced to explain the condition. These may be briefly summarized as follows:

1. *The Paralytic Theory.*—W. Pasteur believed massive collapse to be the result of paralysis or inhibition of the muscular forces expanding the lung. He says, "Whenever—whether as the result of paralysis or of reflex inhibition of muscular action—the distending force acting on the lungs becomes less than that of the elastic and muscular agencies which tend to cause its contraction, the latter, so to speak, takes charge, with the result that the affected portion of the lung rapidly empties itself of its contained air." He points out that immobility of the diaphragm may be due to (a) Paralysis. (b) Reflex inhibition caused by: (1) Inflammation. (2) Pain. This theory is not sustained by the results of experimental paralyses of the diaphragm, and does not seem adequate.

2. *The Obstructive Theory.*—It is of course known that when a bronchus becomes completely occluded by a foreign body the alveoli supplied by it lose the air they contain by absorption and atelectasis results. Chevalier Jackson has shown that diphtheria cases in which bronchi have become plugged with membrane sometimes show the same clinical and X-ray findings as cases of post-operative massive atelectasis. The great majority of post-operative cases cannot, however, be explained on such grounds.

3. *The Theory of Combined Obstruction and Impaired Respiratory Force.*—Elliot and Dingley, in reporting eleven cases, draw attention to the fact that they all show muco-purulent sputum and fever. Churchill concurs with them in the opinion that "Collapse is the result of a combination of obstruction of the bronchioles by inflammatory œdema and secretion and reflex immobility of the diaphragm." He goes so far as to say that bronchial obstruction is essential for the production of massive collapse. He further

suggests that obstruction of a bronchus may occur through compression of an adjacent patch of broncho-pneumonia. It is his opinion that in some cases the element of obstruction may predominate, while in others the dominant factor is diminished respiratory force.

4. *The Postural Theory.*—Briscoe disagrees with Elliot and Dingley as to obstruction being an essential element of massive collapse etiology. He believes that "collapse of the lower lobes is a natural sequence of prolonged quiet breathing in the supine position in such patients as do not use the abdominal muscles to fix their chests." In this connection it is an interesting fact that during the war many cases of massive atelectasis were noted in men who had superficial wounds of the *opposite* chest wall. These men naturally lay on the uninjured side, their weight tending to inhibit the motions of that side of the chest.

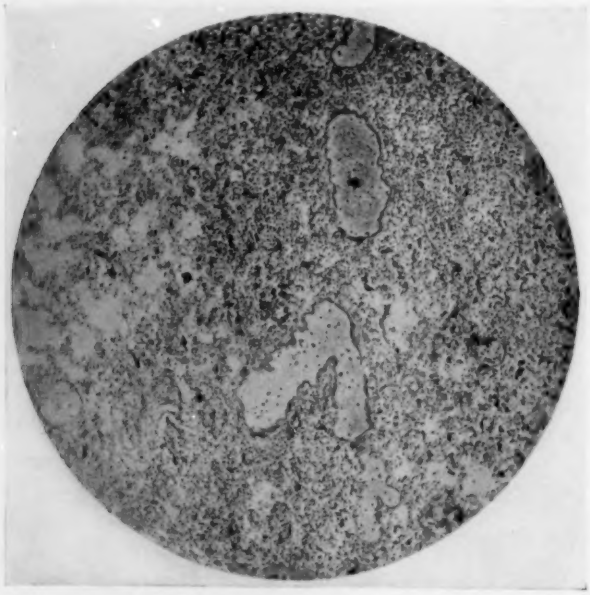

FIG. 2.—Photomicrograph, lung section, Case I.

5. *The Vasomotor Theory.*—Gwyn mentions the possibility of massive atelectasis being due to some vasomotor cause. Scott, in the summary of his excellent article, says: "The mechanism of massive atelectasis appears to be a reflex blocking of the finer air passages in the affected lung tissue, quite possibly of vasomotor origin. The fact that atelectasis can be produced in the lungs of frogs by vagus stimulation lends color to this theory."

6. *The Theory of Reflex Spasm of the Bronchioles.*—It is conceivable that spasm of the bronchioles might close them off and allow the absorption of the alveolar air. We know, however, that in asthma, where the bronchioles are in spasm, the result is the opposite of atelectasis, namely emphysema.

7. *The Angioneurotic Theory.*—It has been suggested that the condition in massive collapse is akin to that in angioneurotic œdema of other tissues. The frequently abrupt onset and rapid clearing up of the condition, and the histological findings, go well with this theory.

If the true etiology of this interesting and important surgical complication is to be determined, it is essential that all cases coming to necropsy be carefully studied, recorded and reported.

While massive atelectasis of the lung in its usual clinical manifestation

is a benign complication, interesting rather than alarming, it is perfectly obvious that its benign nature depends on its being unilateral. Should the collapse involve the major portion of both lungs simultaneously, the inevitable result would of course be the immediate death of the patient. That this may take place is, we think, shown by the cases here reported.

As for the bearing of these cases on the etiology of the condition, there are several points to be emphasized. They give us a measure of the rapidity with which collapse may take place. In Case No. I, for instance, the chest signs were perfectly normal before operation. Throughout the operation the patient's breathing was quite natural. There was no indication at all of any respiratory disturbance. In fact she was in such good condition and so nearly awake that the anæsthetist had left her to start the anæsthesia on the next case, when she stopped breathing. This extreme rapidity of onset would in itself seem to rule out the theory of obstruction of the bronchi with subsequent absorption of the alveolar air as the etiological factor in this case.

Another point of interest is that the gross examination of the collapsed lungs gave no evidence of bronchial obstruction. There were no gross particles in the bronchi. Neither was there any of the muco-purulent secretion so strongly emphasized by Elliot, Dingley and Churchill as a probable etiological factor. The lung tissue was not œdematous in the ordinary sense of the word. The bronchioles and alveoli did not contain any excess of fluid above the normal.

Finally, these collapsed lungs present a striking histological picture. The uniform dilation and engorgement of the capillaries, arterioles and venules strongly suggest the probability of a vasomotor disturbance. At the same time the swollen, hydropic appearance of the epithelial cells lining the alveoli and bronchioles gives the impression of an interstitial œdema. The question naturally arises—may not this be a condition identical with or closely akin to angioneurotic œdema?

SUMMARY

1. Post-operative atelectasis, or massive collapse, is usually a benign, unilateral condition, occurring from a few hours to a few days after operation.

2. The collapse may, however, be bilateral and may occur at, or immediately after operation, and cause sudden death.

3. The extreme rapidity of onset of such cases tends to disprove the obstructive theory of the etiology of the condition.

4. There was no evidence of gross obstruction of the bronchi of the collapsed lungs at necropsy.

5. The histological appearance of these lungs strongly suggests that the cause of the atelectasis may be a vasomotor disturbance of reflex origin, possibly identical with or closely akin to angioneurotic œdema.

6. We hope the report of these cases will lead others carefully to record and report similar cases coming to necropsy. We urge that in cases of death during or after operation from obscure causes, where necropsy is not feasible,

post-mortem röntgenograms of the chest be taken to determine whether or not massive atelectasis is present.

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EMBOLIC AND METASTATIC PHENOMENA IN PLEURAL AND PULMONARY INFECTIONS*

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The frequent association of brain abscess with intrathoracic suppuration, especially with bronchiectasis, has been noted by so many clinicians and pathologists that this complication is, no doubt, immediately suggested by the title of this paper. The startling manifestations of cerebral air embolism occurring during thoracic operations, the irrigation and dressing of thoracic wounds, or during simple exploratory or therapeutic chest aspiration are next uppermost in our thoughts.

Schorstein,[1] in his thesis on Abscess of the Brain in Association with Pulmonary Disease, reported 19 cases, of which 14 occurred in bronchiectasis. Of 69 instances collected and analyzed, 38 were of bronchiectasis and 15 of empyema, these two groups constituting more than three-fourths of the total. In 63 cases of bronchiectasis, cerebral abscess was the second most common cause of death. Concerning empyema as a cause of cerebral abscess, he noted that it had occurred when the pus in the pleural cavity had been undiscovered, when it had been merely aspirated, and when it had been evacuated by rib resection. It was usually in cases which had not healed long after operation that this grave sequel supervened. The danger of epileptiform attacks and sudden death during irrigation of empyema cavities was thought due to dislodgement of a thrombus from a pulmonary vein, but in no case had an embolus been found in the brain. In view of more recent knowledge we must assume that these were instances of air embolism.

Of Schorstein's own cases, 11 were single brain abscesses, 8 being in the left hemisphere. Of 33 solitary abscesses in a series of 51 collected cases, 25 occurred on the left side of the brain. The rarity of infarcts or abscesses elsewhere in the body was noted, but no figures on this point were given. Martius,[2] including three of his own, collected 22 cases of brain abscess of intrathoracic origin. Of 9 solitary abscesses, 7 were in the left hemisphere. In six cases, moreover, metastatic abscesses elsewhere in the body were discovered at autopsy, in the kidneys, the liver, the spleen, the heart muscle, and the ovary. Of five cases of empyema three probably had a coexisting pulmonary lesion to which the cerebral complication may well be ascribed (profuse purulent expectoration, 2; fetid pus in the empyema cavity, 1).

Lord [3] reports one case of cerebral abscess complicating empyema in which lung abscess could not be demonstrated at autopsy. In two others, foci of pulmonary suppuration were found.

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Schorstein pointed out the virulence of these cerebral complications, the patients dying in three to twenty-eight days after the first clinical manifestations. Up to the time of his paper, 1909, no case had recovered. Recently Barling [4] and Hurst [5] each report an operative recovery. In Barling's patient an abscess of the right occipital lobe was drained one month after the lung abscess was drained, the patient having entered the hospital with both lesions. Hurst's patient was known to be well thirteen years after an abscess of the right parietal lobe had been operated by Percy Sargent. This case was one of empyema following operation for acute appendicitis.

In considering embolic phenomena in pleural and pulmonary infections several questions presented upon which little definite information was to be found in the literature. Do emboli from this source lodge in parts other than the brain? Are such emboli always septic? If so, do they always result in suppurative metastatic lesions? Does the occurrence of peripheral embolic phenomena in a case of empyema always indicate an underlying suppurative focus in the lung? If not, how may such instances be explained?

For accurate answers to these questions I realize that careful and complete postmortem and bacteriological examinations are essential, but few facts seem available. During the years 1918 and 1919, when lung suppuration and empyema followed so frequently in the wake of the influenza pandemic, a number of unusual embolic and metastatic complications were noted which upon purely clinical grounds threw some light upon these queries. Subsequently additional cases were observed on the surgical services of the hospital. In the period 1918 to 1926 about 550 cases of empyema and 150 of pulmonary suppuration were admitted to the surgical wards. Brief reports of cases bearing upon the subject of this paper are appended together with comments upon them.

ASEPTIC CEREBRAL EMBOLISM

Case I.—History No. 23–14, 1919, M. K., male, age fifteen years. Following bilateral influenzal pneumonia he developed a sterile left pleural effusion which later became purulent and was drained. During his convalescence a right empyema appeared. Intercostal incision for drainage was performed; the culture showed Streptococcus hæmolyticus. Two days thereafter a right hemiparesis and sensory aphasia were noted without convulsive phenomena. This lasted only a few days. Recovery was complete.

Case II.—History No. 23–4, 1919, F. C., male, age sixteen years. Following influenzal pneumonia a left pleural effusion had been discovered and evacuated by Potain. A week later the temperature rose to 104° F. and sudden left hemiplegia occurred without loss of consciousness. On admission to the hospital two weeks later he presented a left hemiplegia and a left pyopneumothorax. The latter was drained by intercostal incision. Dakin's solution could not be used because of bronchial fistula. The chest healed. The paralysis of the left face and arm cleared up, but a spastic condition of the left lower extremity persisted. When seen four years later the boy still dragged the left leg.

Case III.—History No. 24A–1, 1919, N. L., female, age three years. Two weeks before admission the child had pneumonia. A week later discoloration of the right foot and leg was noted by the parents. On admission she presented a dry gangrene of the right foot and lower two-thirds of the leg with a sharp line of demarcation. The

popliteal, femoral and external iliac arterial pulsations were not palpable on the right side. There was neither fever nor leucocytosis. Examination of the chest revealed dulness and broncho-vesicular breathing over the right upper lobe. X-ray examination showed an infiltration of the right upper lobe, an unresolved pneumonia. Five days after admission a complete right hemiparesis developed evidently due to cerebral embolism. Amputation was performed below the right knee, there was no bleeding from the stump, but the wound healed well. The hemiparesis disappeared entirly in two weeks. The amputated limb showed recent red thrombi in the veins, and proliferation of the media into the lumen of the arteries. No embolus was found in the arteries of the specimen, but it is to be remembered that no pulse was felt in the external iliac artery, the occlusion probably being higher up in the common iliac. Convalescence was uninterrupted.

Comment.—In none of these cases was any cardiac lesion demonstrable clinically to which these embolic phenomena might be traced. In the third case physical findings and X-ray examination demonstrated an unresolved pneumonia and it is reasonable to ascribe the embolic lesions to thrombi in the pulmonary veins of the diseased lung parenchyma. In the second case the cerebral embolism bore no relation to the therapeutic Potain aspiration, and took place before the operative intervention. The presence of air in the empyema cavity and of the bronchial fistula which became apparent after thoracotomy are sufficient evidence of a lesion in the lung tissue itself. It is possible that the embolus in this instance was of low grade infectivity and that a certain amount of brain tissue was irretrievably damaged without suppuration developing, as evidenced by the recovery of the patient with a residual spastic paralysis of the lower extremity. In the first patient transient hemiparesis occurred two days after intercostal incision for empyema. We know from experience in other fields of surgery that embolic phenomena (pulmonary embolism) occur usually ten to fourteen days after the surgical intervention, when thrombi in the operative wound are set free. From the other two cases we concluded that the embolus was traceable to the pulmonary lesion. It is therefore reasonable to assume that the same holds true in this instance, especially since the empyema was due to a pneumonic process in the lungs. If the embolus, moreover, were ascribed to a thrombus in a vessel of the operative wound we should have to assume a patent foramen ovale to account for its lodgement in the brain. From the rapidity with which the cerebral lesions cleared up it is likely that the embolus was small and aseptic.

The following additional cases of cerebral embolism were also observed: A man of sixty years operated for empyema following influenzal pneumonia was stricken with aphasia and right hemiplegia ten days after operation and died. A man of forty-five operated upon for bronchiectasis, a two-stage pneumotomy being performed, had a secondary hemorrhage requiring tamponade. Lft hemiparesis occurred and he ceased two days thereafter. A man of thirty-six, previously operated for post-pneumonic lung abscess was readmitted for hæmoptysis. While his chest was being punctured with an exploratory needle, he became unconscious, right facial palsy and deviation of the eyes to the left were noted. He ceased soon thereafter, embolism of the left hemisphere being suspected. The brain was not obtained but the lung showed a residual small bron-

chial cavity surrounded by a hemorrhagic infarct which was probably the site of puncture by the needle. This may have been a case of cerebral air embolism. In two cases of sudden death five and eight days after operation for empyema, brain examinations were not obtained, but in one miliary lung abscesses were present with thrombosis in a pulmonary vein and in the other bronchiectasis communicating with the empyema cavity. In a man of thirty-nine with suspected lung abscess and empyema, right hemiparesis occurred eleven days after drainage of the empyema, but he made a rapid recovery therefrom.

EMBOLISM OF ARTERIES OF THE EXTREMITIES

Case III.—Reported in detail, was one of embolic vascular occlusion of the right lower extremity in addition to hemiparesis due to cerebral embolism. Three additional cases of peripheral vascular occlusion are herewith briefly reported.

Case IV.—History No. 23–58, 1918, H. B., male, age sixty-two years. The present illness began two months ago with fever, cough and expectoration, at times blood-tinged. Two quarts of fluid were removed from the right chest two weeks before admission. The man was poorly nourished and cyanotic, the fingers were clubbed. In the left axilla there were diminished breath sounds and coarse sticky râles. Posteriorly there was dulness from the apex to the angle of the left scapula and flatness from there to the base. The heart sounds were of poor quality, but no murmurs were discernible. X-ray examination of the chest showed infiltration of the left lung extending above the level of a collection of fluid in the pleural cavity. The left eighth rib was resected and an encapsulated empyema cavity with rigid walls, containing foul pus, was evacuated. Four days after operation there was sudden severe pain in the right upper extremity. The radial and brachial pulse disappeared, the axillary pulse still being palpable. The fingers and arm became limp, at first very pallid, later cyanotic. The patient ceased five hours after the vascular occlusion occurred, with symptoms suggesting cerebral embolism.

Case V.—History No. 25–16, 1925. Reported through the courtesy of Dr. A. V. Moschcowitz. A. D., male, age eight years. Lobar pneumonia followed by pleural effusion. On the afternoon of admission the chest was aspirated and the doctor noted blanching of both lower extremities, mottled appearance of the skin and disappearance of the pulsation in both femoral arteries and the arteries distal to them. A diagnosis of saddle embolus of the aorta was made by Doctor Moschcowitz who operated as soon as possible, although the child's condition was poor. At laparotomy the aorta and both common iliac arteries pulsated. An embolus was removed from the left external iliac artery. This proved sterile on culture, and although containing numerous leucocytes showed no bacteria on section. Because of the patient's grave condition, the right iliac artery was not attacked. The patient ceased a few hours later.

Case VI.—History No. 25–40, 1926. Reported through the courtesy of Dr. H. Neuhof. M. P., male, age forty-one years. Foul sputum for ten years, five to twenty ounces per day. Fever at times. General deterioration and loss of twenty pounds recently. There were physical signs and X-ray findings of pneumonic infiltration of the left lower lobe. The fingers were clubbed. At operation the lung was found adherent. The parenchyma was less infiltrated than expected and bled very little. Numerous dilated bronchi were opened, thick-walled and containing pasty material. No large cavity was encountered as had been hoped for. Six days after the exploration and establishment of bronchostomy there was sudden agonizing pain in the right lower extremity. Twenty minutes later a similar attack occurred in the left lower limb. The pain subsided in about an hour. On examination the right femoral pulse could be felt for one inch below Poupart's ligament, the limb was warm and the color good. The left femoral pulse and the left popliteal pulse in the upper part of the popliteal space were

palpable, but the foot was cold, mottled and numb. The color subsequently improved. Oscillometric readings showed definite impairment of circulation in the legs, more marked on the left side. There was gradual improvement and on the third day both legs were warm, the left not as warm as the right. There was tenderness of the left popliteal artery below the point where the pulse could be faintly distinguished. Later this pulse became more distinct and the tenderness disappeared. There was complete functional recovery of the extremities.

Comment.—Four cases of embolism of the arteries of the extremities have been presented in patients suffering from various pulmonary lesions, namely, unresolved pneumonia, lobar pneumonia with pleural effusion, pneumonic infiltration with empyema, and pulmonary suppuration. In two cases there was evidence of cerebral embolism as well. The two last cases were probably instances of saddle emboli lodging at the bifurcation of the aorta, then breaking up to be carried into the more distal arteries of both lower extremities. Although two patients ceased, the others recovered without clinical indication of any infectious agents being carried in the emboli. In this group of cases as in the preceding group it seems reasonable to ascribe the emboli to thrombi in the pulmonary venous radicles. One cannot, of course, deny the possibility of trauma (aspiration or operation) as an exciting cause for their liberation into the greater circulation, but only when the embolic phenomena follow promptly upon the trauma is it reasonable to believe so.

METASTATIC INFECTIONS

Thus far cases of aseptic embolism resulting in occlusion of relatively large peripheral arteries have been described. If perchance any of the emboli carried bacteria with them, they were either of very low virulence or the factors of local resistance were so great that suppuration did not supervene. In dealing with distant septic phenomena complicating pleural and pulmonary infections, a distinction may be made between septic embolism and metastatic infections. This distinction is one rather of degree than of kind. In septic embolism an infected thrombus is thrown off from a pulmonary venous radicle into the blood stream and lodging in a peripheral artery produces firstly, the effects of local vascular occlusion as do aseptic emboli, and secondly, suppuration in the infarcted tissue when the bacteria proliferate and invade this area and its surrounding tissues. In metastatic infections bacteria, either singly or in clumps, are thrown off into the circulation either directly or through the lymphatics and lodge in the capillary bed or smaller arterioles of distant parts where they produce suppuration. If the primary infection is in the zone of the greater systemic circulation these bacteria either lodge in the lungs, or may succeed in filtering through the pulmonary capillary bed and reënter the general circulation. They produce in the former instance miliary lung abscesses or in the latter, abscesses in the kidneys, spleen, bones and joints, or brain. If the primary infection is in the lung, however, such bacterial emboli pass from the pulmonary veins to the left auricle and thence

directly into the general circulation. The resulting lesions are known as metastatic abscesses or infections.

The following are cases of such peripheral metastatic suppurative lesions originating from a primary intrathoracic focus.

Case VII.—History No. 23–73, 1918, S. S., male, age thirty-seven years. Pain in right chest fourteen days. Pain in right knee four days. Dyspnœic, cyanotic. Herpes labialis. Signs of consolidation of left upper lobe, with fluid at the base. The right knee was red, swollen and contained fluid. A large empyema was drained by intercostal incision, culture streptococcus hæmolyticus. The right knee was aspirated and irrigated, culture streptococcus hæmolyticus. Ante-operative blood culture, sterile. Ten days after operation hemorrhage from the empyema cavity and profuse hæmoptysis caused death. There was no autopsy.

Case VIII.—History No. 25–21, 1919, D. L., female, age two years. Cough, dyspnœa, and blood-streaked sputum for three weeks. Bronchoscopy showed no foreign body but the bronchus to the left lower lobe was dilated. June 6, 1919, operation for left empyema revealed a multilocular lung abscess of the lower lobe which was drained. June 20, 1919, swelling of right thigh which upon operation proved to be an epiphysitis of the upper end of the femur, culture Staphylococcus aureus. There was eventual destruction of the upper part of the femur and disappearance of the head of the bone. With immobilization after osteotomy healing took place. Subsequent X-ray of chest showed numerous thin-walled cavities occupying the entire left lung.

Case IX.—History No. 23–78, 1919, W. E., male, age four and one-half years. A patient operated elsewhere for post-pneumonic empyema four weeks before admission had a discharging sinus of the left chest. The ramefying sinus was laid open and packed. Two weeks later he was readmitted for fever and swelling of the right thigh. X-ray showed periostitis of the upper half of the femur. At operation a perforated epiphysitis of the upper end of the femur was found. Later the lower epiphysis became involved. Culture, staphylococcus aureus. Although blood culture was negative, a pyarthrosis of the ankle developed, and he died.

Case X.—History No. 23–79, 1919, W. L., male, age fifty-nine years. Operated for left empyema, constant discharge from wound ever since. Six weeks ago fever and chills followed by headache which has been getting progressively worse, and pain in the right knee. Nightsweats, loss of weight. Soft, tender, red swelling of the forehead with œdema of both eyelids. X-ray of chest showed only density of the left apex. The skull showed a destructive lesion of the frontal bone on the left side.

Probing the chest sinus yielded two ounces of thick dark red pus. Incision of the scalp abscess revealed osteomyelitis of the skull. Under observation the destruction of the skull bones progressed rapidly over the vault. The right femur was explored but no pus found. Blood and spinal fluid Wassermann negative. Antiluetic treatment had no effect. He died two months after admission. No autopsy was obtained.

Case XI.—History No. 25–21, 1920, G. S., female, age forty-two years. Sore throat and chills followed by pneumonia. X-ray showed unresolved pneumonia of right lung. While under treatment a suppurative arthritis of the knee developed which required extensive incisions for drainage. Culture, streptococcus hæmolyticus. She recovered with an ankylosis.

Case XII.—History No. 23–50, 1921, F. S., male, age four years nine months. Operated for left empyema, post-pneumonic, culture streptococcus hæmolyticus. Three days later right epididymo-orchitis, then left. The left subsided, the right suppurated and was incised, culture streptococcus hæmolyticus. Recovery.

Case XIII.—History No. 25–23, 1924, L. L., female, age three and one-half years. Pneumonia of right lower lobe followed by empyema. Culture of latter upon operation

showed pneumococcus and streptococcus hæmolyticus. A week later pyarthrosis of left hip which was drained and yielded the same organisms on culture.

Case XIV.—History No. 23–25, 1925, R. G., female, age twenty years. Bronchiectasis since infancy. Two weeks ago chill and fever followed by swelling in right gluteal region. A large deep foul-smelling abscess was incised, which on aërobic culture yielded no growth. Anaërobic cultures were not made. Blood culture was negative. At post-mortem bronchiectasis of right and left lower lobes was found with purulent bronchopneumonia. No lesions were observed in the pulmonary veins.

Case XV.—History No. 25–35, 1926, A. Z., female, age twenty-nine years. This patient had a bronchostomy performed for abscess of the right upper lobe. A month later she had chills and fever and developed painful swelling of the left knee, then the right knee, the right elbow and other smaller joints. Blood cultures yielded streptococci. About three weeks later there was a hemorrhage from the bronchial fistulous tract and she died. At post-mortem an undrained abscess of the right upper lobe was found. The pulmonary vessels were negative.

Comment.—These nine cases of intrathoracic infection varied considerably in character including pneumonitis, empyema both recent and old, lung abscess, and bronchiectasis. The microörganisms found in the metastatic lesions were the ordinary pyogenic ones, streptococci and staphylococci. In only one case (No. 14) did the metastatic lesion assume the foul character of anaërobic infection which is so commonly present in the lung suppurations. The sites of predilection for these organisms thrown off into the general circulation were the joints, the epiphyses and the flat bones. In only one instance (Case No. 15) was a bacteriæmia demonstrated. No lesions of the pulmonary veins were found in those cases which came to autopsy, a finding which conforms to the conception of metastatic infection.

BRAIN ABSCESS

When the subject of brain abscess secondary to pleural and pulmonary infections is considered the distinction between embolic and metastatic cerebral lesions is somewhat difficult to maintain. I have already shown that aseptic cerebral vascular occlusion may occur in both suppurative and non-suppurative pulmonary inflammations, probably due to thrombosis in pulmonary venous radicles. Further post-mortem evidence of this mechanism will be given subsequently. It has also been stated that bacteria entering the blood stream from the lung or from infections in the field of the greater circulation can reach the brain without any demonstrable lesion of the veins in the vicinity of the primary focus. On the other hand, thrombosis in the pulmonary veins draining a suppurating area of the lung may be of the infective variety, *i.e.*, a purulent thrombophlebitis. Fragments of such a thrombus breaking off and lodging in an artery of the brain would first cause vascular occlusion with its resulting clinical phenomena, and then cause suppuration of the infarcted area. If, however, a few bacteria or a clump of bacteria enter the brain and gain a foothold there, an insidious onset of cerebral symptoms would occur as the resulting area of suppuration would develop

more slowly and gradually. This would be so especially if a shower of organisms entered the brain and set up a diffuse encephalitic process.

The clinical manifestations of cerebral suppuration secondary to intrathoracic disease have been so well described and are so well known that detailed histories of the cases observed on the wards of the Mount Sinai Hospital will be omitted. Of seven surgical cases suspected only three were in condition for exploratory craniotomy. In two the abscess was found. No case recovered. One clinical fact is of importance, namely that, in general, embolic phenomena occur especially in those patients who have hæmoptysis or who have post-operative hemorrhage from the lung after pneumotomy for drainage.

POST-MORTEM OBSERVATIONS

In an effort to substantiate the statements made as to the pathogenesis of the embolic and metastatic phenomena observed in pleural and pulmonary infections, I have reviewed the post-mortem records of the Mount Sinai Hospital since 1918. Complete examination including the brain was procured in 18 cases, of which 15 were cases of lung suppuration. There was one case of lobar pneumonia with purulent encephalitis, one of bronchopneumonia and empyema with no demonstrable abscess complicated by abscesses of the kidney, one of bronchopneumonia and empyema complicated by meningitis. In these three cases no lesion of the pulmonary veins was demonstrable, the complications probably being in the nature of metastatic infection. In the fifteen cases of pulmonary suppuration the following complications were noted: cerebral air embolism, 1; brain abscess, 6, of which 3 were single and 3 multiple; infarct of kidney, 1; abscesses of both kidneys, 1; gluteal abscess, 1; suppuration of sacro-iliac synchondrosis, 1. In four of the cases lesions of the pulmonary veins in the vicinity of the suppuration were demonstrated, recent and organizing thrombi, phlebitis, arteriovenous aneurism. Each of these four patients presented embolic lesions, either in the brain, the kidneys, or the bones (sacro-iliac synchondrosis). Thus of 18 cases examined, 15 showed lesions in distant organs. In two other cases of lung suppuration only the brain was obtained and in each a single abscess of the occipital lobe was found with rupture into the ventricle causing sudden death.

In 43 cases complete examination except for the brain was obtained. The following secondary lesions were noted: infarction of spleen, 2; abscesses of kidney, 2; multiple joint infection, 1; peritonitis, 1. In two cases a cerebral lesion was suspected but the brain was not obtained. In four cases lesions of the pulmonary vessels were demonstrated; purulent thrombophlebitis, 2; eroded veins in wall of abscess, 1; thrombosis of small artery with infarction of lung at site of exploratory puncture (sudden death), 1.

In 42 cases examination of the thoracic organs alone was obtained. In four of these thrombosis in pulmonary veins radicles was found.

Thus, in 98 cases pulmonary vascular lesions which did or could produce

embolic phenomena, were observed in 12 instances. It seems probable that if more detailed examination with reference to this point were made, the incidence would be still greater.

AIR EMBOLISM

The occurrence of sudden collapse and possibly death upon exploratory puncture of the chest or lung was long ascribed to pleural shock. Epileptiform attacks and death during irrigation of empyema cavities was thought due to the dislodgement of a thrombus and its lodgement in the brain. More recent study of these cases, however, for example by Naegeli of Garre's Clinic,[6] ascribes these phenomena to cerebral air embolism brought about by injury of a pulmonary venous radicle by the exploring needle or the scalpel. Air from the exterior, from the pleural cavity or from a pulmonary bronchus or cavity is sucked into the veins, enters the left heart and thence passes to the brain. Examination of the fundi may show air bubbles in the retinal vessels. Convulsions followed by unconsciousness and then amaurosis are characteristic of this syndrome. Reyer and Kohl [7] of the U. S. Army have reported ten cases complicating therapeutic pneumothorax due probably to transfixation of anastomotic vessels in pleural adhesions. By way of prophylaxis a large calibred blunt needle is recommended in refilling the chest, keeping the head of the patient lowered during and after the procedure.

In six cases of the series which I reviewed cerebral air embolism was suspected, but only one in which post-mortem examination confirmed the diagnosis is herewith reported.

Case XVI.—History No. 25–36, 1926, R. L., female, age twenty-one years. Post-tonsillectomy lung abscess. Three years ago a two-stage pneumotomy was performed. Bronchial fistula persisted. At times there was hæmoptysis and bleeding from the fistulous tract. Patient admitted for severe bleeding and hæmoptysis. The tract was exposed and explored for source of hemorrhage. An artery in the wall of the pulmonary tract was ligated and divided. Ten minutes after operation was begun the patient died suddenly. At the post-mortem examination air was demonstrated in the left ventricle and in the vessels of the brain.

CONCLUSIONS

The peripheral complications of pleural and pulmonary infections may be classified as embolic and metastatic.

The embolic complications may be aseptic or septic. They may occur in both non-suppurative and suppurative lung infections, but chiefly in the latter. They are referable to thrombotic and phlebitic lesions of the pulmonary veins. They may involve not only the brain, but the arteries of the extremities. They may also involve the spleen and the kidneys.

In cases of empyema the embolic complications should be referred to the underlying pulmonary disease and not to the empyema *per se*. Of 69 cases of empyema coming to autopsy, inflammatory lesions were present in the

lungs in every instance. Of these 47, more than two-thirds, showed miliary or large abscesses, bronchiectasis, gangrene, etc.

Metastatic infections of the soft parts, joints, epiphysis and flat bones occur in pleural and pulmonary infections. They are more frequent in cases with empyema, bronchiectasis and lung abscess than in simple pneumonitis.

The clinical observation of the association of embolic phenomena with hæmoptysis and post-operative hemorrhage is in accordance with the post-mortem evidence of vascular lesions in the lung parenchyma as the underlying causative factor of such phenomena.

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SUBCUTANEOUS RUPTURE OF THE LIVER*

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Injury of the liver as the result of non-penetrating violence, *i.e.*, subparietal rupture is rare enough in civil practice to justify reporting eleven additional cases. For the privilege of adding ten of these, I am indebted to my colleagues of the German Evangelical, Englewood, St. Bernard's, South Shore and Wesley Memorial Hospitals. The eleventh case occurred in the author's practice. Before reviewing our present information as to the mechanism, diagnosis and treatment of such injuries, a summary of the chief clinical features of the eleven cases will be given.

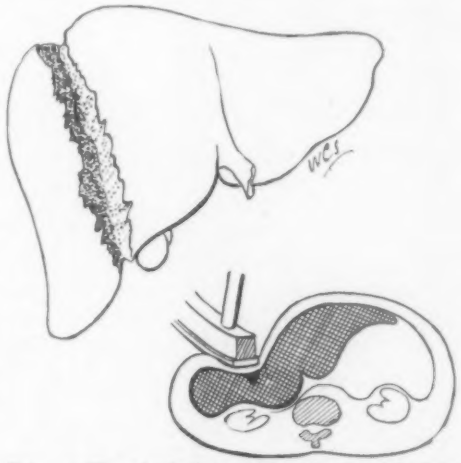

Fig. 1.—The wheel of a vehicle split the right lobe down to the posterior capsule. Fatal hemorrhage.

Case I (Dr. J. F. Hultgen).—Boy of thirteen run over by wagon. Marked shock, thirst, pallor and dulness all over abdomen. Slight rigidity. At operation large amount of blood free in peritoneal cavity. Right lobe of liver torn off (Fig. 1) also rupture of spleen. Died without being able to check bleeding.

Case II (Doctors Rickfort and Weinberger).—Boy of eight crushed by rear axle of automobile. When seen thirty-four hours after injury, pulse 100, temperature 101, vomiting of bile-stained fluid, dulness on right side of abdomen and flank. At operation hemorrhage from tear in right lobe of liver apparently controlled by packing, but died twelve hours later. Autopsy revealed a tear (Fig. 2) in extraperitoneal surface of right lobe of liver.

Comment.——Symptoms of visceral (liver) rupture did not develop until thirty-four hours after injury. Drainage and transpleural packing might have been successful.

Case III (Dr. W. R. Abbott).—Man of twenty-three crushed between two freight cars. Extreme shock, marked rigidity; radiography revealed fracture of pelvis. Apparent recovery after conservative treatment. Suddenly on seventeenth day enormous distention and also dulness across upper abdomen developed. At operation large amount dark liquid blood found; also extensive tear (Fig. 3) of both lobes and gall-bladder. Liver wound packed. Recovery.

Case IV (Dr. A. J. Graham).—Boy of nine run over by automobile, wheel passing over right side of abdomen. Severe shock, right rectus rigidity for two hours, then sudden rise of pulse rate and death two hours later. At autopsy complete separation (Fig. 4) of right and left lobes of liver. Extensive retroperitoneal hemorrhage. Operation refused shortly after accident.

Case V (Dr. D. E. Meany).—Man of twenty-four fell across rail. Treated for

* Read before the Englewood Branch, Chicago Medical Society, November 2, 1926.

fracture of ribs. Symptoms of paralytic ileus on following day. On third day rapid pulse, dulness, rigidity and abdominal pain. Operation (third day): Long tear (Fig. 5) in right lobe. Recovery complicated by empyema requiring resection of rib.

Case VI (Dr. L. H. Stern).—Male adult fell from scaffolding fifty feet high on abdomen. When seen next day, sixteen hours later, pulse rapid, pallor, right rectus rigidity. At operation much free blood with detached portion of right lobe lying free (Fig. 6) in peritoneal cavity. Hemorrhage controlled by mattress sutures. Recovery.

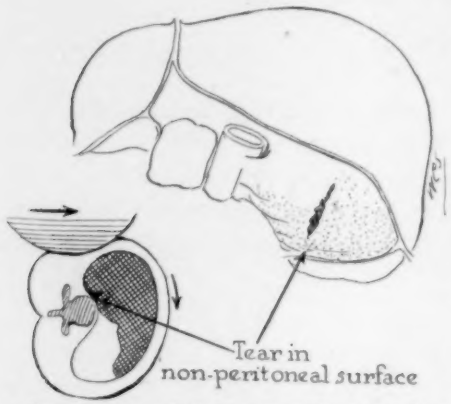

Fig. 2.—Boy rolled between differential of an automobile and the ground, causing a rupture of the liver on the non-peritoneal surface, and perinephritic hemorrhage.

Case VII (Dr. J. A. Shacter).—Woman of thirty-one struck by wheel of an auto across abdomen. Pallor, abdominal rigidity and increased liver dulness. At operation one hour later deep rupture (Fig. 7) on anterior surface of right lobe closed by suture. Recovery.

Case VIII (Drs. J. T. and E. J. Meyer).—Man of twenty-eight struck by iron band over right upper quadrant. Tenderness and rigidity over this portion of abdomen, also pallor, thirst, and rapid rise of pulse rate (96 only). At operation five hours after accident found (Fig. 8) deep right lobe tear. Hemorrhage controlled by packing. Death ten days later after high fever for last two days.

Case IX (Dr. J. B. Haeberlin).—Boy of thirteen run over by heavy truck. Shock, pallor, pulse slow and weak. Dulness over entire abdominal cavity. At operation three hours after accident three fragments of liver tissue found detached (Fig. 9), also extensive tear of right lobe, which was packed. Recovery.

Case X (Dr. W. G. Epstein).—Girl of ten struck over dorso-lumbar region by automobile. Marked abdominal rigidity, pain, and evidences of free fluid. At operation three hours after accident two-inch tear in inferior surface (Fig. 10) of left lobe found and packed. Recovery.

Case XI (Dr. A. G. Scherer).—Fell across steel platform. When examined fifteen hours later, pulse 130, very little rigidity, but liver dulness extended to umbilicus. Died thirty hours after injury. No operation performed. At autopsy liver showed tear on under surface of right lobe (Fig. 11) with much free blood and pus in peritoneal cavity.

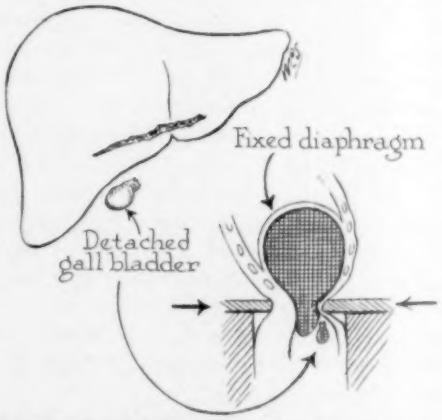

Fig. 3.—Crushed between freight cars. Rupture of the liver and gall-bladder. Fractured pelvis.

Of these eleven cases of subcutaneous rupture of the liver herein reported four (Nos. I, II, V, and XI) died as the result of delayed or faulty diagnosis or both. Some of these fatalities were due to incomplete surgical examination upon admission. Three of these cases were sent home only to be brought back to the hospital after the abdominal symptoms had become more pronounced.

SUBCUTANEOUS RUPTURE OF THE LIVER

Injury to the liver follows generally certain mechanisms and is for the most part of two varieties: (1) A certain circumscribed striking force, as falls, horse-kicks, or explosions (as Cases Nos. V, VIII and XI); or (2) the forcible approximation of two rigid planes, one behind the spinal column and fixing it, the other plane in front forcing the liver against the forward curving lumbar vertebræ (as in Cases Nos. I, II, III, IV and IX). In Case No. IV such a mechanism caused a sagittal rupture between the two lobes by flattening them over the vertebral column just as a saddle is flattened over the wethers of a horse.

FIG. 4.—Automobile passed over abdomen, causing sagittal rupture. Hæmatoma in omental bursa and retroperitoneally.

SYMPTOMS AND DIAGNOSIS

A. General Shock Symptoms.—The cause of the symptoms of shock must be ascertained whether it is due to the primary single impact, or is being produced by continuous sensory nerve irritation due to the flooding of the peritoneal cavity by blood, bile or visceral contents.

In liver lesions the pulse usually rapid, small and sometimes slow is, following the sudden fall of blood-pressure, accelerated to 140–160. This sudden circulatory failure, actually observed in Case No. IV, occurs sooner and oftener in internal hemorrhage than in visceral perforation.

B. Local Abdominal Symptoms.—The diagnosis of abdominal injuries is based upon three findings, (1) dulness due to hemorrhage, (2) tympanites, and (3) involuntary muscular rigidity.

1. *Abnormal Dulness.*—This is positive proof of liver injury. It appears early, extends laterally and above the symphysis. Bulging in the cul-de-sac of Douglas is present only if the patient has been in the upright position.

If the blood escapes from the torn liver in small amounts it clots near the point of traumatization as in Case No. IV, where clots formed posteriorly between the separated lobes and floated the intestines up, causing tympany instead of dulness. In many instances the dulness is small, questionable, not present until four to six hours after the trauma, and often not until the next day (Cases II, V, VI and XI). Blood in the abdomen is much less mobile than fluid in ascites (Fothermeyer's sign). Shifting dulness is delayed several minutes.

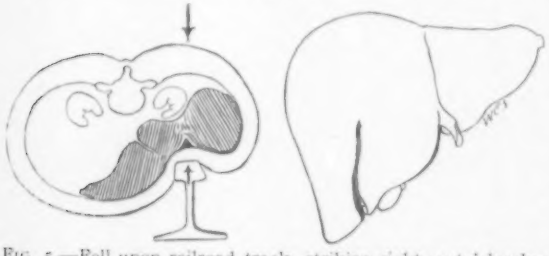

FIG. 5.—Fell upon railroad track, striking right costal border upon rail. Walked a mile. Empyema.

2. *Tympanites.*—Just what causes a bowel to lose its motor activity,

dilate and become filled with gas is not as yet fully understood. Either the vagus is paralyzed, or irritation of the sympathetic produces an excessive inhibition of peristalsis. (We can understand how powerful peristaltic waves obstructed at the injured point of the intestine would exhaust the muscles of the bowel above trying to bridge over the gap—and produce a paralyzed and tympanitic intestine). Pressure or injury to the retroperitoneal plexuses would reflexly influence the play of nerve impulses to and from the bowel, and explain the enormous tympanites mentioned by Thole as produced by crushing the pancreas or liver against the vertebral column, or by pressure of retroperitoneal hæmatomas.

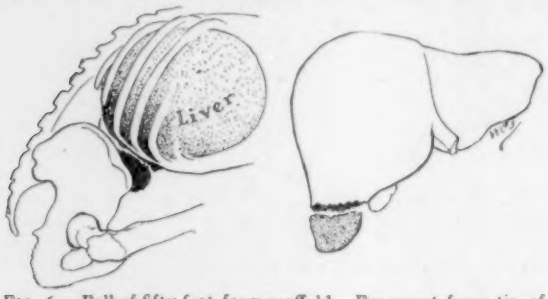

FIG. 6.—Fall of fifty feet from scaffold. Fragment from tip of right lobe found free in cavity.

Disappearance of Liver Dulness.—The distended loops of intestine displace the liver upward, diminishing or obliterating the liver dulness. This disappearance of liver dulness is often given as proof of an abdominal lesion and wrongly so. In intestinal perforation large free pneumoperitoneum is rare; and there must have been a sufficiently large quantity of gas expelled from the full stomach or intestine into the peritoneal cavity.

Therefore, post-traumatic diminution of liver dulness is not of itself a proof of an intra-abdominal injury, but if tympany and post-traumatic diminution of liver dulness is accompanied by an increasing abnormal dulness, an abdominal lesion is almost certain to be present.

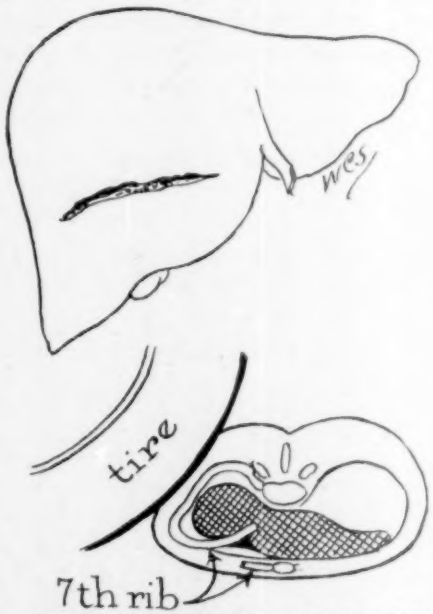

FIG. 7.—Automobile wheel passing over body fractured the seventh rib which lacerated the right lobe of the liver.

3. *Involuntary Rigidity.*—In liver injuries the abdominal muscles become immediately tense, often locally so, especially in the right upper quadrant of the abdominal wall. Involuntary muscular rigidity is caused by the irritation of the sensory ends of the intercostal and lumbosacral nerves in any portion of their course (Fig. 12). It occurs when the parietal peritoneum is irritated, and is therefore absent only when the pathology is not in contact with the walls of the abdominal cavity.

We observe abdominal rigidity during pleurisy, pneumonia, lung injuries or fracture of the ribs through direct irritation of the intercostal nerves as a reflex, or as irritation of the posterior roots of the spinal nerves in fracture of the spine, or in retroperitoneal hemorrhage.

Differentiation Between Chest and Abdominal Injuries.—It is difficult to diagnose a liver lesion when the thorax is also traumatized especially on both sides. Thoracic lesions obscure the abdominal symptoms by restricting respiration as a result of irritation and reflex immobilization of the diaphragm, and by producing reflex tenderness and rigidity in the upper abdomen. Noetzel thought that in thoracic lesions pain on pressure and rigidity could not possibly reach farther down than the umbilicus. He refers to a gunshot wound of the left lung in which persistent board-like rigidity and excessive tenderness induced the surgeon to laparotomize the patient without finding any lesion of either diaphragm or abdominal viscera.

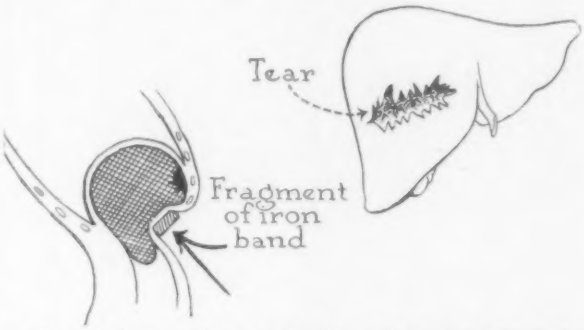

FIG. 8.—A piece of iron band with explosive force struck the right costal border which with the fixed diaphragm composed two polar forces causing an equitorial rupture of the liver capsule.

Differentiation between chest and abdominal trauma or disease is well illustrated by the following simple case:

V. S., age eight, was thrown by an automobile, her chest striking a four-inch high curbstone at the level of the fourth rib. Hæmatemesis, pallor, shock, pulse 110, and abdominal rigidity. The X-ray revealed fracture of the fourth rib, one inch from the sternum, and of the tenth rib one-half inch from the spinal column.

Because of the hæmatemesis and rigidity of the right rectus she was watched for an abdominal lesion. The pulse went up to 128, but soon dropped to 108. After watching the patient for three hours the initial shock disappeared and color came to the lips. The abdomen retracted to restrict respiration over the broken ribs, and so the girl's appearance indicated a clearing of the uninjured from the injured cavity as a ship clears a pier in shoving off.

FIG. 9.—The wheel of a two-ton truck passed diagonally over the abdomen, crushing the right lobe of the liver, and injuring the left kidney and bladder.

DIFFERENTIAL DIAGNOSIS OF INTERNAL HEMORRHAGE

(a) *From Perforation.*—Rupture of a full stomach or urinary bladder also shows dulness. This dulness increases more rapidly with internal hemorrhage than with peritonitis, but sudden flooding of the peritoneal cavity with stomach contents produces a simultaneous peritonitis with its signs (pain, temperature, vomiting, rigidity) so abruptly

that in most cases we can make a diagnosis of peritonitis before one of hemorrhage or rupture. Such a perforation of the stomach can be differentiated from hemorrhage by the rapid disappearance of liver dulness which is due to pneumoperitoneum. Such disappearance requires several hours in hemorrhage.

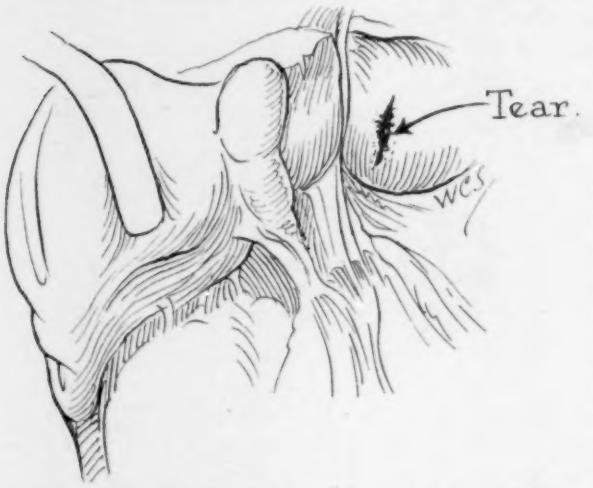

FIG. 10.—Speeding automobile struck the patient in the back, causing an over-extension of the spinal column, and tearing the left lobe of the liver, producing hemorrhage.

In general, we can diagnose internal hemorrhage earlier than visceral perforation because of the characteristic local symptoms of abdominal dulness and the muscular rigidity due to hemorrhage, and because the general symptoms of acute anæmia appear earlier than the local symptoms of a peritonitis.

(b) *From Peritonitis.*—In this instance it takes time for enough exudate to collect to produce dulness (thirty-one hours in Case No. XI), therefore it is too late in appearing to be of any diagnostic value.

Late disappearance of liver dulness or late crowding out of the same is a classical symptom of advanced peritonitis. It is produced by a paralyzed and tympanitic intestine, and rotates the liver upon its edge by pressure from below.

The Dangers of a Liver Rupture.—Liver hemorrhage is dangerous because (a) the blood-pressure in the portal system is low, the bleeding marked and continuous, and the thin-walled, hepatic veins without any valves tear easily and gape without retracting or contracting.

FIG. 11.—Fell six feet bending body to left sharply over a steel platform. The tear caused in the right liver lobe resulted in peritonitis.

(b) Because the liver blood mixed with bile coagulates very slowly.

(c) The liver vessels have only a very few vasomotor fibres in comparison with the kidney, spleen and intestinal vessels.

(d) Because the respiratory movements of the diaphragm and abdominal wall produce a continuous blood-pressure variation.

For these reasons spontaneous hæmostasis of a liver wound is very rare.

In secondary hemorrhage from liver injury the blood-pressure is raised by some violent act as coughing, or getting up. The occluding thrombus is loosened, the tear enlarged and the secondary hemorrhage begins. It may occur from the third to the fortieth or fiftieth day after injury and sudden death result.

An intra-abdominal hemorrhage can lead by either mechanical or chemical processes to reflex ileus, acute gastric dilatation and cardiac paralysis without infection and cause death, not by hemorrhage but by its reflex effects. Later on, some of the collections of blood may suppurate and cause a fulminant peritonitis (Case XI).

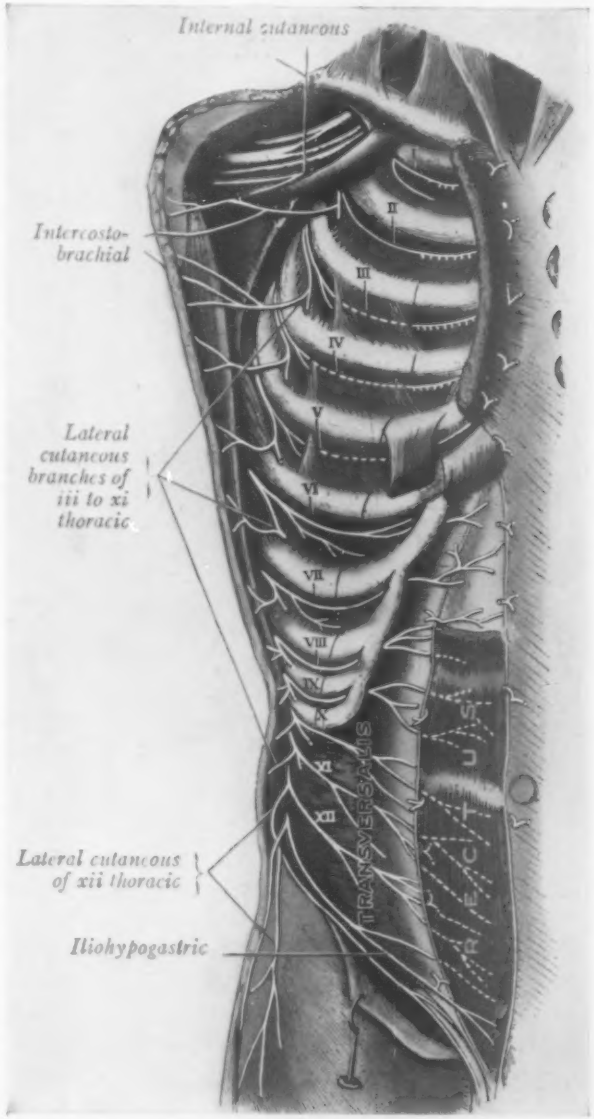

FIG. 12.—Drawing showing the intercostal nerves, the superficial muscles having been removed, to aid in showing the predominance of rigidity of chest or abdomen in disease or injury. (From Lewis' 20th Edition, *Gray's Anatomy*.)

OPERATIVE TREATMENT OF LIVER INJURIES

If initial shock continues in liver injuries one should operate within three hours. It is dangerous to wait for dulness to form. The mortality of abdominal lesions increases with every hour.

Technic.—(a) *Preparation:* During the observation period and as long as the diagnosis is in doubt let the patient have no morphin, nor anything by mouth.

(b) *Incisions:* The median epigastric incision (Fig. 13) is the simplest. It is far enough away from the hilus to permit delivery of a part of the liver outside of the abdominal cavity. It may be closed in three layers by resorting to Stiles' method of splitting the rectus fascia to secure tissues for suturing in three layers.

Kausch's incision (Fig. 13) is the best flap method to use in conjunction with the median epigastric.

(c) *Displacing the Liver* (Fig. 14): Judd called attention to the fact that only by keeping the incision near the median line can the liver be rotated upward by bringing the free edge of the right lobe out of the abdominal wound, and thus bring the gall-bladder and gall-ducts into better view. This rotation occurs with the hilus as the centre and with a radius reaching to the tip of the right lobe six to eight inches away. The tension on the ligaments bring down the diaphragm which is partially fixed, making the respiratory excursions rapid and shallow. This manœuvre will succeed only in flexible livers, but it gives an excellent view of the under surface of the lobes.

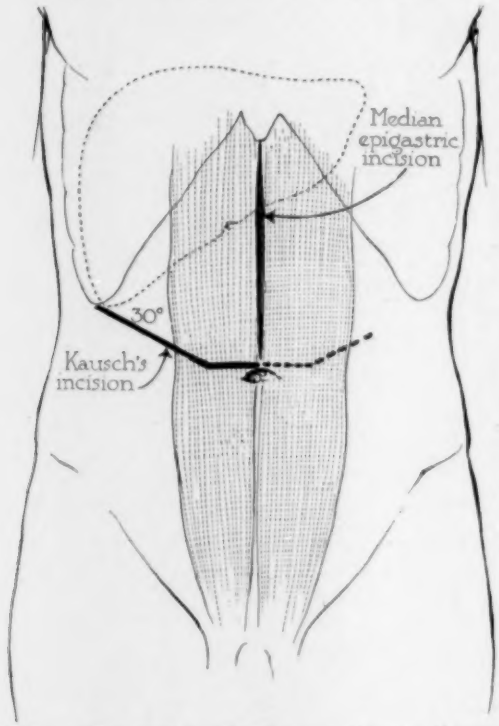

FIG. 13.—The median epigastric and Kausch's diagonal flap incisions.

(d) *The Transpleural Field.*—In stab wounds of the lower thorax the Italian and Russian surgeons use transpleural incisions very successfully. Neither the median epigastric nor the Kausch incision are adequate to take care of a wound of the dome. It is always safer to begin with the medium epigastric incision in order to orient one's self, to palpate the rupture, and then to make the transpleural incision especially if the wound is posterior and lateral.

After the abdomen is opened the assistant by making bilateral pressure can control the hemorrhage in sagittal rupture. The hepato-duodenal ligament may also be compressed while temporary packing is inserted and renewed while the suturing is done, working slowly and synchronously with the respiratory excursions. In the more serious cases in the search for the source of a profuse intra-abdominal hemorrhage the work is facilitated, according to Thole,[1] by compression of the aorta immediately below the diaphragm by means of Dahlgren's aortic compressor. After the course of the hemorrhage has been found the hepato-duodenal ligament is compressed with a rubber-covered Murphy intestinal clamp, while the aortic compression is maintained, and is safely left *in situ* one-half hour or until the liver injury has been taken care of.

There are only two procedures of definite hæmostasis, packing and suture.

Packing or Tamponade.—Fixing the Liver: It is best to fix the liver by

packing it away from the diaphragm, so that the gauze will take up the movement of the respiratory excursion and leave the liver packed down low and in good view. Packing is then placed between the liver and the costal border to remove from the liver any lateral movement from the ribs. Tamponade is

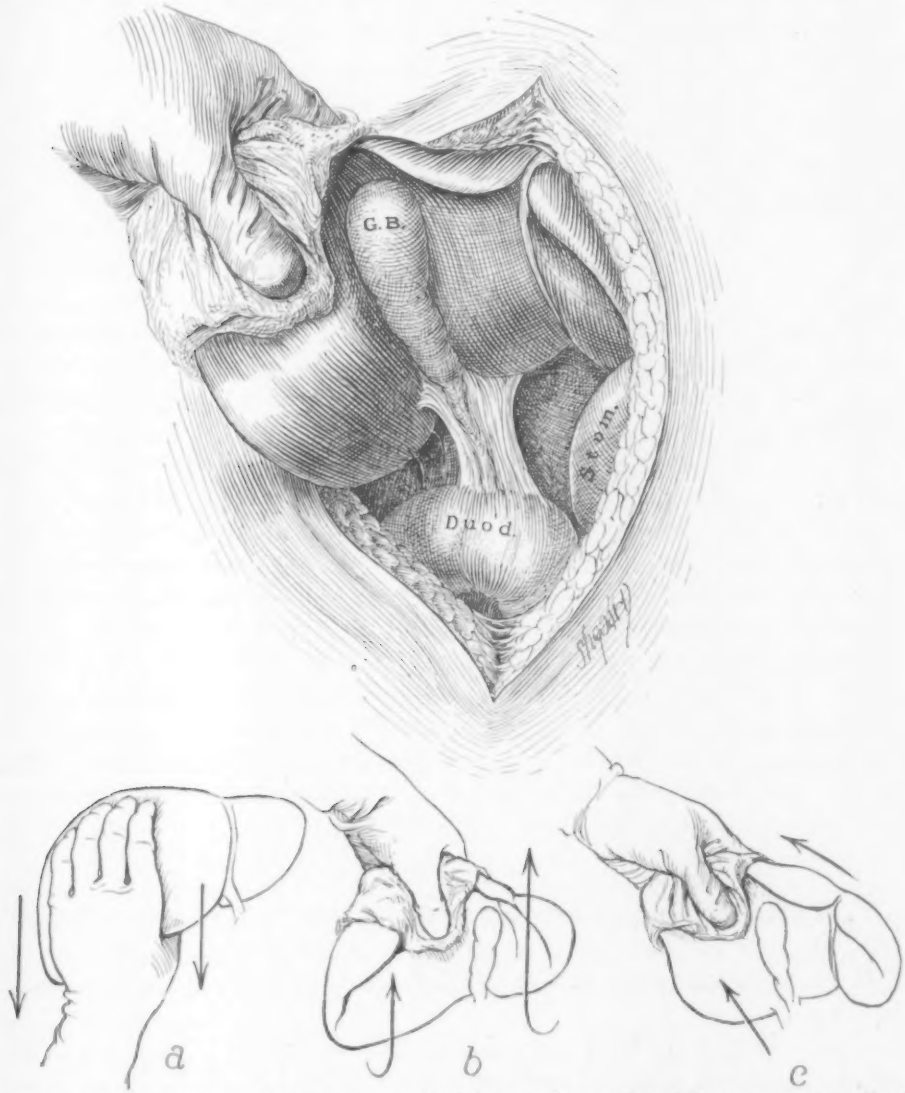

FIG. 14.—Displacing the liver for the exposure of its inferior surface consists of three movements, *a* direct downward traction, *b* rotation anteriorly and *c* rotation at right angles to the right costal border.

then applied directly to the liver wound firmly and with no haphazard methods. The danger of all tight packing is ileus of the bowel from obstructing the portal circulation and splanchnic nerve impulses in the hepatoduodenal ligament.

Suture.—This is the ideal method since it exuviates the bile to the lumen

of the bowel, its normal course—a very probable reason why subphrenic abscesses are more frequent with packing than with suture.

A special needle has been devised (Fig. 15) to use in the gloved hand to secure a firm grasp in order to sew securely against active hemorrhage, no needle-holder being necessary. Sutured liver wounds are very painful due to the presence of many sensory nerves in Glisson's capsule.

Advantages of Suture.—(1) Because it restores to a certain extent the normal conditions of the liver.

(2) Since we can close the belly by primary suture, healing takes place more rapidly and the danger of herniation and secondary infection is practically nil.

FIG. 15.—Corrugated needle to be held by the gloved hand for assuring a firm grasp in placing deep sutures for control of active hemorrhage.

(3) Being required to examine the liver for suture assures a more thorough examination.

Advantages of Packing.—(1) Easier and speedier.

(2) You can pack wounds that you cannot reach to suture.

(3) In case of secondary hemorrhage this can be recognized and treated earlier.

(4) In case of suppuration drainage is present at once.

The *indications* then are: Suture whenever there is no contra-indication, that is, in all smooth stab or rupture wounds accessible for suture, and when the condition of the patient allows time for doing it.

Use *tamponade* (1) in all gunshot tunnels; (2) in all tears or ruptures of the liver with contused, crushed or torn edges; (3) when the condition of the patient calls for quick termination of the operation, with the liver wound too large for suture, or when in an inaccessible situation; (4) in specially friable tissue; (5) when the liver wound is near the hilus and the larger vessels are torn and their ligation impossible.

RÉSUMÉ

The liver is the most frequently injured internal organ. Its partial fixation, its shape and its composition render it easily injured. In children the liver is larger and more friable while at times they are more reckless as to danger.

Shock is of two kinds, (1) primary traumatic and (2) that due to the continued bombardment of the nervous system.

The sudden acceleration of the pulse to 140–160 due to fall of pressure is almost characteristic of internal hemorrhage.

As primary shock passes away the local symptoms determine the presence of an abdominal lesion. Abdominal dulness is the only positive sign of a lesion.

There is something sudden to a perforation while in peritonitis we have a distinctly gradual and progressive development.

The diagnosis of liver lesions is often not possible until the next day. *If it cannot be based upon abnormal dulness then we must depend upon the disappearance of liver dulness produced by gradually developing tympanites caused by hæmatomas or injuries interrupting the nerve impulses at the base of the mesentery.*

Involuntary rigidity of the abdomen is a valuable reflex symptom and if watched will indicate which cavity, the chest or the abdomen, *has the severest injury as indicated by the predominance of its rigidity.*

Progressive vomiting is an indication of continued peritoneal irritation, or interruption of the peristaltic impulse. Internal hemorrhage is distinguished from visceral perforation by the predominance of the general symptoms of an acute anæmia over the local symptoms of a peritonitis.

Circumscribed spontaneous pain in the liver region, radiating shoulder pain, increase of liver dulness upward or downward, sometimes also decrease of liver dulness through meteorism, firm local blood collection, circumscribed rigidity in the liver region—all these point to the liver as the source of hemorrhage.

Dangers.—Hæmostasis of a liver wound is difficult because of the character of the tissue, because of the presence of bile, and because of the respiratory movements. Peritonitis is the intermediate danger; secondary hemorrhage, subphrenic abscess and empyema are the chief remote dangers.

The surgeon should watch the patient personally for several hours.

The mortality of liver injuries is at best above 40 per cent.

The median epigastric and Kausch diagonal incisions serve all purposes on the ventral surface. Displacing the right lobe out of the abdominal wound brings the lower surface into good view and access. The transpleural field is reserved for suture and packing of wounds of the dome and posterior surface.

By compression of the aorta and of the hepato-duodenal ligament the hemorrhage may be immediately checked.

The liver is fixed by packing it away from the diaphragm and costal border. Suture is the ideal method; packing for an emergency.

Post-operative nausea and vomiting may be due to compression of the hepatico-duodenal ligament, its blood-vessels or its splanchnic nerves.

The greatest skill is hæmostasis; the greatest error, hasty examination; the greatest virtue, speed.

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INDICATIONS FOR SURGICAL TREATMENT OF MEGACOLON*

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Under the terms Congenital Dilatation of the Colon, Hirschsprung's Disease, and the more general one of Megacolon, are grouped a number of conditions affecting the colon. These conditions are characterized anatomically by a total or segmentary dilatation of the large intestine with hypertrophy of the walls in the dilated zone. Barrington-Ward [1] points out that the term dilatation of the colon is incorrect in that it does not take note of the hypertrophy, which so usually accompanies the dilatation, and makes no mention of the involvement of the rectum, which is present in a considerable proportion of the cases. Hirschsprung,[2] who first directed general attention to the condition, advocated the term "true" megacolon for those cases manifesting symptoms in infancy and early childhood and "pseudo" megacolon for those cases occurring in later life.

There are many theories in regard to the etiology of the condition, but no single cause thus far discovered satisfactorily explains every case. The etiology, pathology and clinical features have been adequately discussed by a number of writers, notably Finney [3] in 1908. I shall limit myself to a consideration of treatment with special reference to indications for surgery and to the limitations of certain procedures employed.

It is convenient to divide into two classes the conditions which are grouped under the general term megacolon. True Hirschsprung's Disease, Congenital Idiopathic Dilatation of the Colon, is rarely observed. A proportion of the cases reported as such, prove on analysis to be instances of more or less localized involvement of the colon in which there is evident, the element of mechanical obstruction, anatomical or functional. Slight degrees of the congenital defect may apparently exist for years with few or no symptoms. Recognition may be due to accident or to the development of symptoms later in life.

In its typical form the condition is characterized by obstinate constipation with abdominal distention. The constipation is often noted from birth and abdominal distention may be present at birth, but more frequently appears in the second month or later. The greater number of these patients die in early childhood, but some reach adult life and even old age. The prognosis depends upon the extent of involvement and upon the age of the patient. The younger the individual, the more unfavorable the prognosis. The involvement is usually most marked in the sigmoid colon, but the entire large intestine or any portion of it may be the seat of the disease. Exceptionally a normal segment of intestine is present between two dilated portions. The rectum may be involved but is usually normal.

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Males predominate in the proportion of three to one. Diagnosis is rarely difficult. As has been pointed out by Vernon David,[4] congenital stricture of the rectum may result in a condition similar in some degree to the so-called idiopathic dilatation of the colon. It is therefore essential in all cases to exclude the presence of such a stricture. Tuberculous peritonitis, chronic intestinal indigestion and rickets are conditions mentioned as causing confusion. In those rare instances when the patient first comes under observation in adult life, the abdominal distention is usually so great as to be distinctive. Röntgenography after an opaque enema is practically always conclusive.

FIG. 1.—Congenital idiopathic dilatation of the colon (Hirschsprung's disease) in a two-year-old boy.

The outlook is poor whatever the treatment, but inasmuch as compensation is occasionally established, a careful trial of medical measures is indicated. Such measures include a supporting abdominal belt, a low residue diet with restriction of starches, the avoidance of laxatives with the exception of mineral oil and the daily use of high enemas. Massage, electrical treatment and the administration of atropine may be employed. Dilatation of the anal sphincter sometimes proves of advantage. If the condition is not improved or at least held in check, operation is indicated. Operation should be avoided if at all possible in the presence of obstructive symptoms and a bowel distended with fæces. When operation under such circumstances is inevitable, a preliminary colostomy may be indicated. Ordinarily, however, more radical measures give better results.

Procedures varying in extent from ileo-sigmoidostomy to total colectomy in one stage with the implantation of the ileum into the rectosigmoid have been advocated. The sequence practiced by Sistrunk,[5] Hubbard [6] and others appears, on the whole, to be the most promising. Following a lateral anastomosis between the ileum and the sigmoid, the ileum is cut across and both ends closed. Just above the anastomosis the sigmoid is divided, the distal end closed, and the proximal end brought out in the upper portion of the abdominal incision to drain the excluded large intestine. The entire colon may be removed at a later date if the inconvenience of the fistula is such as to warrant this measure. Where the entire colon is not involved the procedure employed by Finney is applicable. This consists in a preliminary colostomy in healthy bowel. Subsequently a lateral anastomosis between the segments immediately above and below the distended portion is made and after complete recovery resection of the affected colon may be carried out.

FIG. 2.—Röntgenogram six hours after opaque enema in a case of congenital dilatation of the colon in a boy of six years. (Dr. Downes' case.)

CASE I.—The following case is typical of the condition. A boy of two was admitted to the Babies' Hospital in July, 1922, with a diagnosis of congenital dilatation of the colon. The history was of a normal delivery at term of a well-developed child. The child was breast-fed to ten months. At the age of three months obstinate constipation and enlargement of the abdomen were noted. With the aid of cathartics and enemas there were four stools a day, but otherwise there were intervals of four days without a stool.

On physical examination the child appeared in fair condition. The abdomen was greatly enlarged and protuberant and the xiphoid-umbilical measurement was much increased. Röntgen-ray examination after an opaque enema showed an enormous dilatation of the entire colon. No kinks or filling defects were noted. There was no indication of involvement of the rectum. After observation for a period of several weeks in the Out-patient Department and one month in the hospital, operation was decided upon. During this period daily enemas resulted in large, constipated or fluid stools.

August 12, 1922, the first operation was performed. Through a left rectus incision

the sigmoid and descending colon were delivered. The diameter of the intestine varied between three and four inches and the wall was greatly thickened. The descending colon and sigmoid were resected and axial anastomosis was effected between the dilated proximal colon and the apparently normal rectosigmoid. The disparity in the size of the lumen made this a procedure of some difficulty. Rubber dam drainage was instituted through a stab wound. Convalescence was complicated by the development of a fecal fistula.

The child was discharged in good condition with wounds soundly healed six weeks after operation. At this time the abdomen was somewhat smaller than on admission. A few days later, however, the child was readmitted on account of increasing abdominal distention and the absence of stools. During this second stay in the hospital the abdomen increased steadily in size in spite of frequent apparently effectual colon irrigations. A second operation was undertaken one month later. Many adhesions were encountered. The terminal ileum was dilated and its wall thickened almost in proportion to the change in the large intestine. The ileum was implanted into the rectosigmoid and the remaining large intestine, with three inches of the terminal ileum was excised. Two days after this operation the child died of peritonitis. In the light of further study of the subject, I believe that an ileosigmoidostomy with exclusion and drainage of the colon would have been a more suitable operation.

FIG. 3.—Röntgenogram after opaque enema in same case as Fig. 2 nine years later at age of fifteen.

CASE II.—I am indebted to Dr. Wm. A. Downes for the history and röntgenograms of another patient who also serves to illustrate some of the phases of the congenital type. In 1917, a boy of six, was seen by Doctor Downes in consultation. There was a life history of constipation and abdominal enlargement. A röntgenogram revealed a greatly dilated colon, the condition being most marked in the sigmoid. The rectum was apparently not involved. At this time an abdominal belt and the usual medical measures were advised. During a period of nine years this boy has developed normally. Regular enemas are necessary, but with this exception he leads the normal existence of a boy of his years. His appearance is healthy and the only notable feature is a somewhat prominent abdomen. A röntgenogram made in October, 1926, reveals a generally dilated colon with an enormous sigmoid loop. A surgeon in another city has advised colectomy. Doctor Downes advises the continuance of conservative measures.

A case such as this affords a real problem. It seems reasonable to assume that there will continue to be a gradual progression of the condition and that

as middle age is approached there will be greater and greater difficulty in emptying the bowel. If surgery were undertaken nothing less than total colectomy or ileo-sigmoidostomy with exclusion and drainage of the colon would be adequate. There is little available knowledge as to the late results of these measures. It seems to me advisable in a case such as this to continue medical measures until there is evidence of increasing difficulty in emptying the colon at which time operation should be done. In the case of patients not sufficiently responsible to carry out the necessary measures or whose social status is not such as to enable them to do so, operation is indicated at once.

FIG. 4.—Acquired Megacolon. Boy of six years. Röntgenogram four days after opaque meal. (Case of Doctor Kerley and Doctor Downes before operation for separation of adhesions.)

To the second class, that of pseudo or acquired megacolon, belong by far the greater number of cases. The patients suffering from this condition usually come under observation late in childhood or in adult life. This type of megacolon may occur as a result of varied conditions; but is most frequently consecutive to a mechanical obstruction. The obstruction may be congenital, but the dilatation and hypertrophy of the large bowel is secondary and does not usually manifest itself in infancy. Redundancy of the sigmoid colon with subsequent rotation or angulation may result in chronic obstruction and consequent megacolon. A valve of mucosa may form at the point of angulation. Intestinal stasis with fecal impaction in the rectum is a further frequent cause. It is possible that the intestinal stasis is due to a congenital defect in musculature or innervation. It is this group which seems to me to offer the most intricate problems in the selection of suitable treatment. To begin with there is wide difference of opinion as to what degree of dilatation of the large intestine constitutes megacolon. Symptoms may be practically absent in a patient in whom röntgenography reveals an apparently greatly

dilated colon, but may be very marked in another patient whose colon seems only moderately involved. Then, too, the normal, or redundant sigmoid, may be so distended by the injection of fluid under pressure, as to present a very deceptive picture. A great deal has been written about the subject. Nevertheless, few observers have had the opportunity of reporting on an extended series of personal cases and it is obviously difficult, if not impossible, to classify adequately, a group of cases derived from many and various sources. Furthermore, with rare exceptions, little emphasis has been placed on the late results of treatment and there are available few well-grounded conclusions, helpful in discriminating between the indications for medical and those for surgical treatment. Save in the presence of acute obstructive symptoms, the first step in the treatment should consist in the correction of any anatomical cause of obstruction. It is true that, even though the obstruction be removed, medical measures will only exceptionally restore to normal a definitely dilated and hypertrophied colon. Careful medical treatment does, however, enable many patients with a very marked degree of megacolon to carry on their lives with little inconvenience from the condition. Such patients are obviously not subjects for radical surgery.

FIG. 5.—Röntgenogram after opaque enema in same case as Fig. 6 eleven years after operation for separation of adhesions.

The following case serves to illustrate this phase of the subject, and I am indebted to Doctor Kerley and Doctor Downes for the history and röntgenograms.

CASE III.—At the age of nine months a baby came under the observation of Doctor Kerley. At that time he was suffering from a recurring intussusception involving the sigmoid and rectum. An exploratory operation was done and a band of adhesions extending from the umbilicus to the hepatic flexure was divided. At the same time the hepatic and splenic flexures were fixed to the anterior abdominal wall to prevent the recurring intussusception of the descending colon into the sigmoid. The intussusception did not

recur, but there gradually developed a dilatation of the entire colon. At the age of six and one-half years, Doctor Downes first saw the boy in consultation with Doctor Kerley. In February, 1916, Doctor Downes operated. The colon, from the hepatic flexure to the sigmoid was dilated. The oral end of the distended segment was attached to the anterior abdominal wall by adhesions and the distal end was kinked by an omental band. This entire segment was so twisted as to constitute a volvulus. The adhesions were freed and the volvulus reduced. Subsequent to this operation careful medical treatment has been persisted in. Eleven years after the operation the boy is well developed, normal in appearance and leads a normal life. He has a megacolon, but the condition has been at least held in check and probably improved by the systematic and careful medical treatment he has received.

FIG. 6.—Röntgenogram twenty-one days after opaque meal. Megarectosigmoid with fecal impaction in a boy of fifteen.

Where the rectum is involved and there is a tendency to fecal impaction, medical measures are often efficacious. In such cases there may be an enormously dilated sigmoid which is directly continuous with a similarly dilated rectum. It is unwise to resect the sigmoid in such a case save as a measure of urgent necessity in the event of volvulus. The diseased rectum remains and there is a marked tendency to persistence of symptoms and recurrence of a dilated sigmoid loop.

CASES IV and V.—In the summer of 1922, two boys, one thirteen and the other fifteen years old, were admitted to the medical service of St. Luke's Hospital. In both the immediate history was of abdominal pain, diarrhœa and loss of weight. In the case of the younger, there was a history of stomach trouble and constipation since birth and he had been under observation at the hospital for a year, with recurring attacks similar to the present one. The older boy gave a definite history of only one month. In each patient there was an enormous fecal impaction with greatly dilated rectum and sigmoid colon. After the relief of the immediate symptoms the patients were transferred to the surgical service and assigned to me for treatment.

Resection of the sigmoid colon was carried out and a little over two feet of intestine was removed in each instance. This portion of the intestine was greatly dilated and the wall thickened. The process obviously involved the rectum. The remainder of the large intestine was relatively normal, though in one case considerably dilated. In this case an axial anastomosis was effected. In the other a lateral anastomosis was carried out on

account of the great disparity in size of the dilated rectum and the apparently normal descending colon.

The immediate result in each patient was excellent, one gaining 22 and the other 29 pounds. There persisted, however, a marked tendency to constipation and in the second and third years after operation each patient had an attack similar in all respects to the ones before operation. Since that time there have been no attacks of such severity and although evacuation of the bowels is irregular, the condition is kept under fair control by the patients themselves.

Because of the tendency to recurrence of symptoms and of the dilated sigmoid loop after partial colostomy, Mirizzi [7] has advocated in such cases a total colectomy with implantation of the ileum into the sigmoid. As the procedure carries with it considerable immediate risk, and little is known of its late results, it seems scarcely justified in such cases as I have described.

In the event of the failure of medical treatment, I should incline to ileo-sigmoidostomy with the exclusion of the colon, and drainage through a colostomy. The colon may be removed at a subsequent operation if necessary.

A similar condition, in a greatly aggravated form, is apparently prevalent in Argentina, and in 1922, Corbin [8] referred to a personal experience of over 200 cases of fecal impaction with enormously dilated rectum and sigmoid. He stresses the almost inevitable recurrence of the condition after relief by medical measures. At times he finds it necessary to open the abdomen and remove the fecal mass either by crushing *in situ* or occasionally through an incision in the intestine. He considers partial or total colectomy not applicable and advises sigmo-rectal plication.

Where the rectum is normal the outlook is much better, and it is in segmentary dilatation of the colon with a normal rectum that surgery has its most favorable field. It is essential that the entire diseased segment be removed. The multiple stage operation of Mikulicz as carried out in such cases by Blake [9] and Dowd [10] is the method of choice, though resection in one stage may be done in very favorable cases. If the patient presents himself in an acute condition, it is of course desirable if possible to empty the distended bowel before operation is undertaken. In the event of failure, operation must be carried out and the measures determined by the individual conditions. The most frequent cause of acute symptoms in this type of megacolon is volvulus. If the condition of the bowel permits, reduction of the volvulus and delivery of the affected segment with a view to a Mikulicz resection is advisable. In many cases, however, this is impossible and the only resource is in an immediate colostomy.

SUMMARY

I have referred to only five cases and yet they represent three distinct types of megacolon and the two cases of one of these types differ greatly in clinical features. This seems to me to illustrate the most characteristic feature of the problem presented by this condition. While the cases do fall roughly into certain groups, the lines are not well drawn either as to the character of the cases or as to the treatment each case requires. It is obvious

that a great diversity exists in the compiled series of cases which furnish the basis for much of the theorizing in regard to the relative value of medical and surgical treatment. It seems to me highly unreasonable to base a selection of treatment in an individual case on statistics resulting from the compilation of a series of cases differing in nature and degree and derived from widely separated sources. No general rule for treatment can be formulated. Type and degree of involvement, and to some extent the intelligence and social status of the patient must be carefully weighed. Medical and surgical treatment each have their indications and limitations and the treatment of each individual case must be decided solely on the merits of that case.

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MUSCLE-FASCIA SUTURE IN HERNIA*

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from the Buhl Laboratory of Harper Hospital

The physiological result in the repair of inguinal hernia is dependent on several important factors:

1. The age of the patient, whether child, adult or aged. 2. The nature of the hernia, whether direct or indirect. 3. The complete removal of the sac. 4. Primary wound healing. 5. Efficient repair of the abdominal wall. Although we have placed repair of the abdominal wall last in this list, it is by no means the least important. In fact, it is in relation to the surgical physiology and histology of this one factor that the following brief experimental study was undertaken.

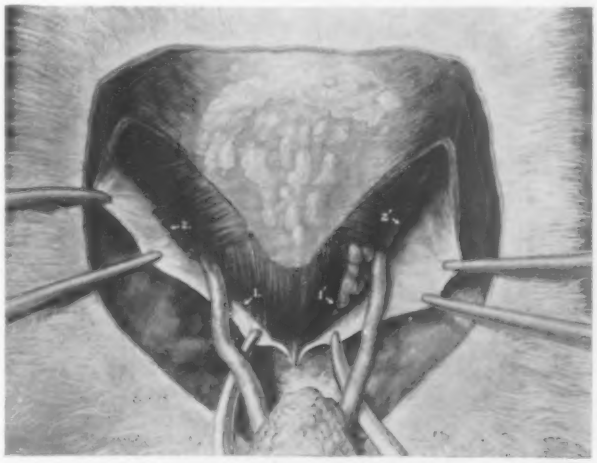

Fig. 1.—Both inguinal regions of dog, forty-one days after operation. 1—Edge of rectus muscle firmly adherent to Poupart's ligament. 2—Edge of internal oblique muscle firmly adherent to Poupart's ligament. 1′ and 2′—The unoperated side.

Should red muscle be sutured to white fascia? As conflicting evidence was found in answer to this question, we were impressed by the necessity of further investigation of the subject. Eminent surgeons could be found who said it was of value, while other surgeons, equally eminent, averred that it was of no value. Men of wide experience state that in their operations for recurrent hernia, the muscle had not adhered to Poupart's ligament; others state that they have seen firm union at re-operation. Seelig, for example, states that he has never seen the muscles and conjoined tendon firmly united to Poupart's ligament. He says, " In practically all instances these structures are widely separated just as if they had never been approximated by suture."

Seelig and Chouke, attempting to get at the basis of this problem by experimental studies on dogs, thought the inguinal canal of dogs so snugly and completely closed as not to permit of additional suturing, so they sutured a reflected edge of fascia lata in the thigh to the underlying muscle. They

* Read before the Detroit Academy of Surgery, February 10, 1927.

say, "In every instance of clean wound healing, the fascia was widely separated from the muscle to which it previously had been sutured." They found that in infected wounds there was sometimes a partial cicatricial union. Even on cutting wedges in the muscle and then inlaying fascia, they concluded that a full measure of success could not be obtained, although no tension was placed on the muscle-fascia suture. Their final conclusion was that normal muscle will not unite firmly with fascia, and that it is a useless procedure to suture the muscles to Poupart's ligament in the repair of a weak abdominal wall.

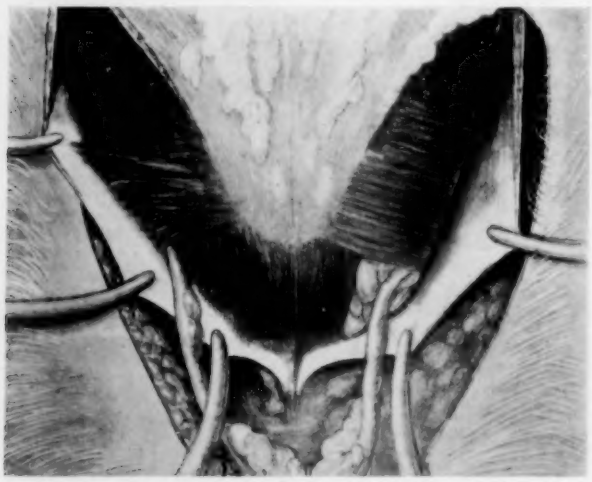

FIG. 2.—Both inguinal regions of dog, sixty days after operation. Right side operated. Firm union of muscle to fascia.

Edmund Andrews agrees with Seelig and Chouke that such union does not occur, and that, theoretically, it would not be expected to occur. He considers it harmful to suture the internal oblique muscle to the ligament, and says that this muscle acts as a sphincter to close the inguinal canal, and that sutures damage the muscle.

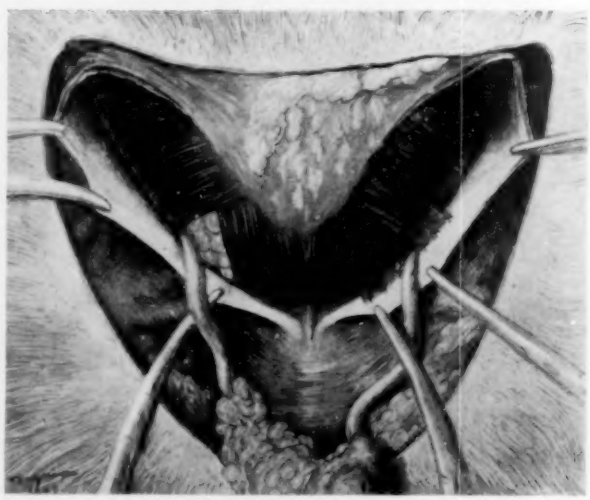

FIG. 3.—Both inguinal regions of dog, seventy-seven days after operation. Left side operated. Sutures show where muscle was approximated to the aponeurosis of the external oblique. Firmly adherent.

Being familiar with the work of Seelig and Chouke, we attempted to repeat their procedure on the thigh of dogs, and endeavored also to find a satisfactory technic in the inguinal region for muscle-fascia suture. While involved in this attempt, we became acquainted with the admirable work of Koontz, who had also repeated the work of Seelig and Chouke with certain modifications. Koontz concluded that the internal oblique muscle and Poupart's ligament unite firmly in the dog, when these structures are brought into

apposition by suture. And he further stated that the fascia lata, when sutured to the underlying muscle, also united firmly if the areolar tissue was carefully removed before suturing.

Gallie and LeMesurier had previously found that even in fascia to fascia suture the areolar tissue should be removed, as otherwise the strength of union would be slight. They conclude also, "That fibrous tissues heal to whatever structures they are placed in contact with, by ordinary scar. The strength of the scar depends on the degree to which the surfaces in contact are denuded of areolar tissue and scarified, and on the area of the surface."

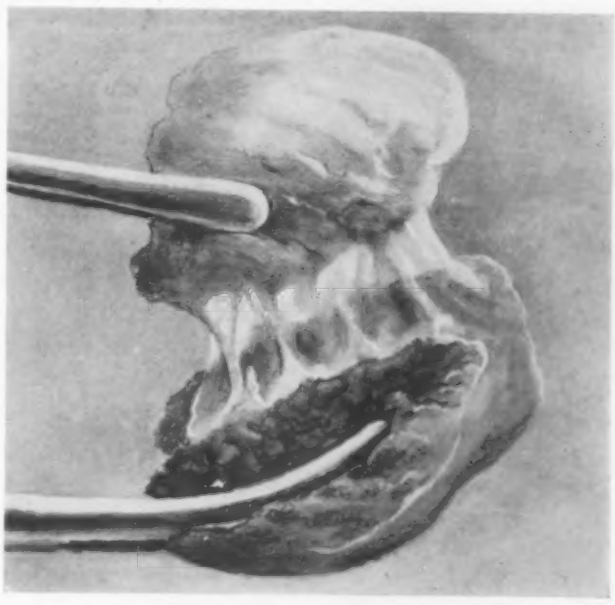

FIG. 4.—Thigh of dog, fourteen days after operation: areolar tissue not removed before the suture of muscle and fascia. No serviceable union.

Twenty-seven operations were performed by us on dogs, ether anæsthesia being used. As the inguinal region in dogs is different from that of man, we were unable to follow the usual technic of hernia repair. In dogs the internal oblique muscle fibres run almost at right angle to Poupart's ligament, and are not attached to it. The rectus muscle, as in man, is attached for a very short distance to Poupart's ligament, while the conjoined tendon is evident for a distance of only 0.5 to 1.0 cm. from the pubes. In our operations, the edge of the rectus muscle was brought over and sutured by interrupted single sutures of twisted silk, to Poupart's ligament, the fascia of the external oblique having been incised as in any hernia repair, and the areolar tissue

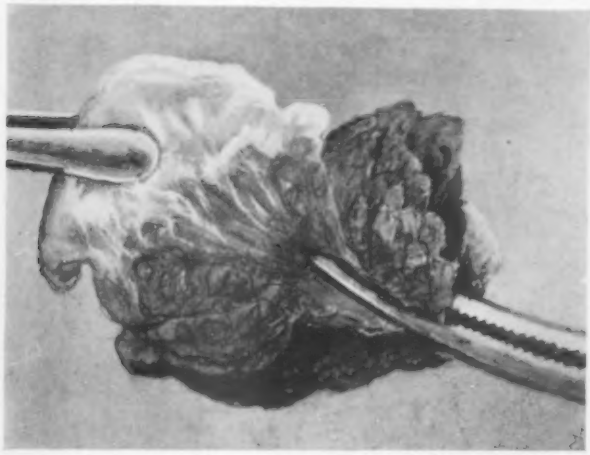

FIG. 5.—Thigh of dog, fourteen days after operation: areolar tissue removed before suture of muscle and fascia. Firm, serviceable union.

elements being gently stripped from the muscle and Poupart's ligament before suturing.

In some cases the cord was transplanted, and in some cases it was not. Also, the internal oblique muscle was sutured to the reflected margin of Poupart's ligament, the areolar tissue being removed as before. As can be seen by the plates, considerable tension was necessary, especially on the rectus muscle sutures. These details are clearly shown in Figs. 1, 2 and 3, which represent the normal and the operated side at forty-one days, sixty days and seventy-seven days, respectively. Firm union between the muscle and fascia resulted in all cases, and was of such character that muscle could be torn from muscle as easily as the union between muscle and fascia could be overcome. All cases were the same, for there were no exceptions. One case, because of severe infection and death by pneumonia, is not included.

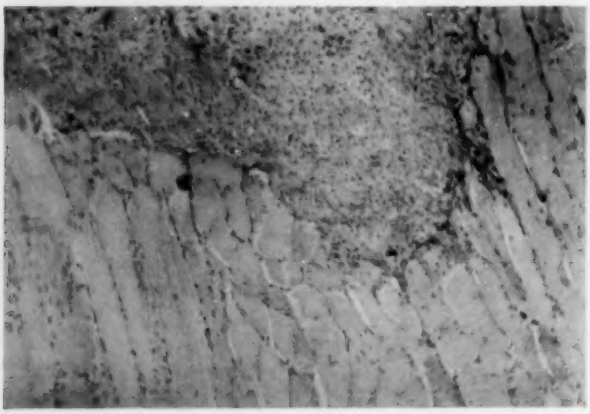

FIG. 6.—Photomicrograph, low power, showing the union of aponeurosis with fascia between and around muscle fibres—many tentacle-like strands anchor the aponeurosis.

In the thigh operations, the anterior iliac fascia was incised, reflected and sutured, so that a counterpart of Poupart's ligament was constructed. On one side of the dog this was sutured to the underlying muscle without removal of the very evident areolar tissue intervening in this region. On the other side the same procedure was used, except that the areolar tissue on the fascia and muscle was carefully removed. The latter side in all cases showed good union of muscle to fascia, whereas the side in which the interposing areolar tissue was not removed, showed very slight union in only one case. (See Figs. 4 and 5.)

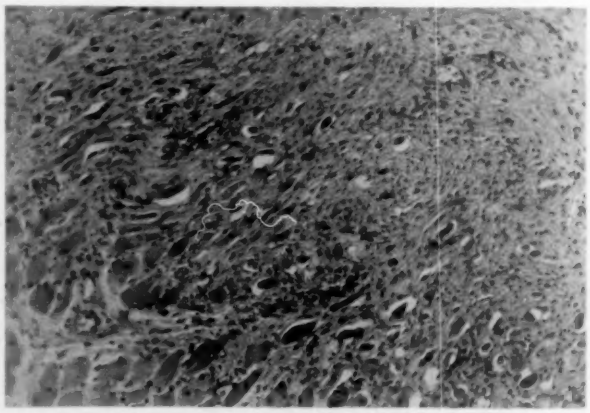

FIG. 7.—Photomicrograph, low power, showing replacement of a few muscle bundles by fibrous tissue, and the union of this with the aponeurosis and the tentacle-like strands in and around the muscle.

We feel, therefore, that the success of the muscle-fascia union depends

on the complete removal of the interposing elements of areolar tissue and fat. To allow this synovial-like membrane of areolar tissue to exist between the sutured elements is to invite just that situation existing in a joint, non-adherence of insulated structures. The term, muscle-fascia union, is misinforming, and has probably caused a portion of the controversy existing on this subject. Despite the fact that one sutures muscle to fascia, the union is as fascia to fascia. Of course one does not expect a red muscle cell to become a white fascia cell. The muscle bundle, however, is surrounded by a sheath of white fibrous connective tissue and each muscle fibre has its neighbor bound to it by the same element, while the entire muscle or group of bundles is likewise held together by white fibrous tissue. The elements for a connective-tissue union are therefore present. As a matter of fact, when muscle is sutured to fascia, without interposing tissue, two things happen: 1. The fascia forms communications with the myomysium, endomysium and perimysium (the white fibrous tissue in and around the muscle). Radiating processes project from ligament to muscle, binding the two firmly together by hundreds of interlacing tentacle-like strands.

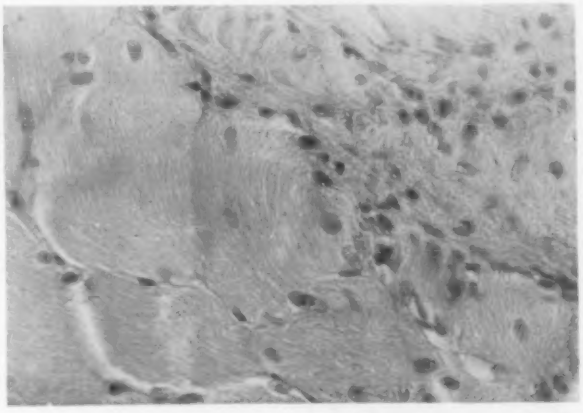

FIG. 8.—Photomicrograph, high-power, showing white fascial cells in and around the muscle bundles. The elements for a true, firm connective tissue union are therefore present.

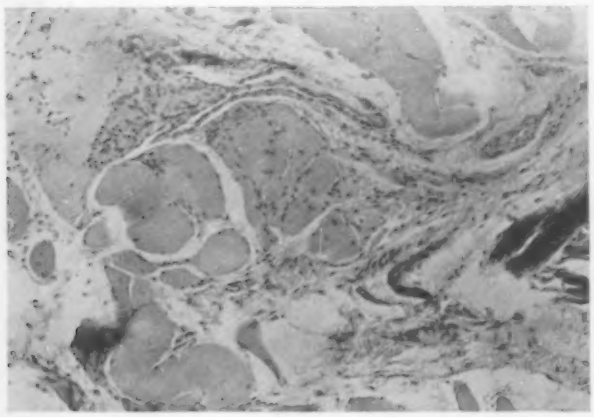

FIG. 9.—Photomicrograph, low power, showing sutures in field of union.

2. A portion of the muscle in contact with the ligament is partly replaced by fibrous tissue. This fibrous tissue is firmly connected with the fibrous elements above mentioned, and with the ligament. This is shown in Figs. 6, 7, 8, 9 and 10.

Andrew's criticism that you destroy the sphincter action of the internal oblique by suturing it to Poupart's ligament seems untenable, for, by so doing one actually keeps the sphincter closed—if it really is such. That you

injure nerve supply and damage the muscle, is not a pertinent objection, if very small portions of the muscle are included in the suture. The muscle may be very slightly replaced by the fibrous tissue at the point of union, but this is advantageous, and makes for firm union.

FIG. 10.—Photomicrograph, low power, showing sutures in field of union.

We do not mean to infer that it is advisable or necessary to suture muscle to fascia in all cases of clinical hernia. The ligation of the sac, the overlapping of the fascia of the external oblique or the method of Pitzman, in which the transversalis fascia is used, may be independently or collectively sufficient in given cases. In severe direct hernia, the more elaborate technic of Gallie and LeMesurier may be decided upon. We do feel, however, that if it appears to the surgeon that a firm union between Poupart's ligament and the rectus or internal oblique muscles would be of advantage in repair, that this union may be assured if the areolar tissue is removed before suturing.

CONCLUSIONS

1. In the literature of hernia, the advisability of suturing red muscle to white fascia is questioned.

2. When done experimentally, firm union resulted in dogs in all cases in which the areolar tissue was removed from the muscle and fascia before suturing. On the thigh of dogs no union occurred when the areolar tissue was left intact.

3. The general type of union is the same as that between fascia and fascia.

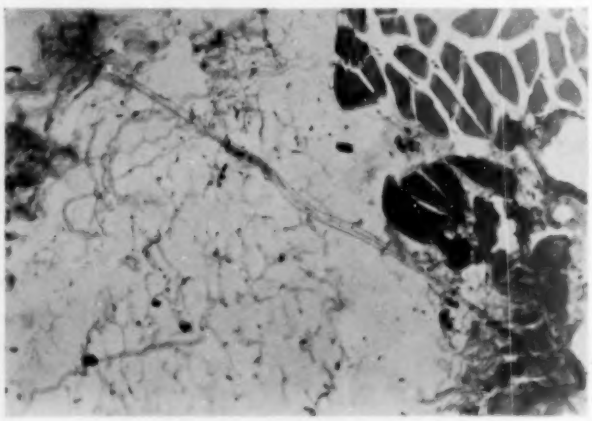

FIG. 11.—Photomicrograph, low power, showing the very evident areolar tissue in an unoperated specimen.

4. In hernia, it is not always necessary to suture muscle to fascia, but when indicated, may be relied upon if areolar tissue is first removed.

NOTE: Since the reading of this paper, Major Seelig has again reiterated his stand on this subject.

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THE PROBLEM OF RECURRENT HERNIA

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When the word hernia was substituted for rupture as referring to sac formation in the inguinal, femoral, umbilical and other locations, it was also applied to the state of affairs following post-operative rupture, or separation of the edges of the peritoneum, muscles and fascia of the abdominal incision made for previous operation. The term "recurrent hernia" has been long and abundantly employed. Have surgeons generally taken the trouble to inquire if the real state of affairs was that of peritoneal sac formation, or rupture of the previous incision?

For many years I have contended that post-operative incisional hernia is a true rupture of the abdominal wall resulting from incomplete or insecure closure of peritoneum and fascia, or the breaking of sutures by such violent and sudden efforts as coughing, vomiting, etc., or the imperfect healing of wound edges as a result of suppuration. This contention can be proven in every case by painstaking naked eye examination at the time of operation. There will be found a break of continuity of the peritoneum and fascia at the site of the previous incision. After a year there will be found at the second operation an easily identified sac which, to superficial examination, resembles in its smooth appearance, the peritoneum. Careful examination, however, shows that it is not true peritoneum and that the line of demarcation between the sac and the true peritoneum can usually be clearly defined. More detailed study of the sac will show that it is ordinary fibrous tissue, much thicker than peritoneum; microscopic examination of a carefully prepared specimen will show that it is not lined with endothelium and does not possess the histologic structure of serous membrane. The sac of this type of rupture is a newly formed fibrous structure, a product of adaptation of the connective-tissue cells of the abdominal wall adjacent to the hole in the abdominal wall and not an outgrowth of peritoneum.

Of "recurrent hernia" there are at least three easily recognizable types. One of these is in no sense a true hernia of peritoneal sac but a post-operative incisional rupture. Because it occurs after an operation for hernia gives us no more reason to think of it as a new hernia formation, than is an ordinary post-operative incisional rupture in some other part of the abdomen. The prevention of this necessitates accurate close suture of the peritoneum, the avoidance of wound infection and of excessive and sudden violent efforts which will produce breaking of sutures and tearing of tissues.

Another and extremely common type of so-called "recurrence" is that in which all the sac of the hernia has not been removed at the primary opera-

tion. This can and does occur even in the hands of the best surgeons when removing the sac from below in the routine way as is commonly employed. The neck of the sac is not tied or sutured sufficiently high. In dealing with large herniæ even the expert surgeon does well to be cautious lest he pull the bladder down and ligate or suture a part of it with the sac, especially of direct hernia and amateurs will do well to obey the impulse of timidity in pulling down with inexperienced hands the sac with the bladder, vas deferens, deep epigastric, and vessels of the spermatic cord in close relation. Actually there are a large number of cases in which at the original operation for indirect hernia the entire sac was not completely separated from the surrounding fascia and had been ligated or sutured at a point not sufficiently high, leaving an inch or more of the original hernia in the inguinal canal. This as time goes on, grows to large size.

The most common example of so-called "recurrence" is at the lower angle of the inguinal canal having the appearance of a direct hernia. These are now recognized as bulging of redundant peritoneum at the location of direct hernia existing at the time of the first operation with the indirect hernia, for which the previous operation was performed. These, therefore, are not true recurrences of hernia, but only the inner sac of the originally present hernia which had never been removed.

The following cases illustrate the different types:

Case No. 23—4322.—A young man was believed to have on the right side an inguinal hernia about the size of a hen's egg and on the left side about the size of an almond. Superficial examination on my part failed to find the hernia on the left side. At operation, through a muscle-splitting incision, into the abdominal cavity an inch above the internal ring on the right side, the hernia was easily recognized and completely removed and the inguinal canal closed under the cord. I doubted if he had a hernia on the left. The man was so sure that he had a hernia on the left side that I explored the left side, made a hasty superficial examination, failed to find a hernia and closed the abdominal wall without further disturbing the inguinal region. Six or seven months later he returned. The second operation found on the left side a small sac about the size of an almond and a neck about the size of a lead pencil. He is now completely cured.

This was in no sense a recurrence, but the same hernial sac which he had originally and which on account of haste and carelessness I overlooked entirely.

2. Case No. 22—4207.—A man, sixty odd years old, thought he had hernia of both inguinal regions. He was thin, his muscles were weak and there was obvious an inguinal and a femoral hernia both on the right side, and bulging, but no true hernia, on the left. Through a muscle-splitting incision an inch above the neck of the hernia on the right side there was found an inguinal hernia about the size of a hen's egg and a femoral hernia about half that large. These were both removed from within. The peritoneum was closed and the canal closed under the cord (Bassini). On the left side, through a similar incision, careful examination showed that there was no hernia, but to prevent subsequent bulging, the canal was closed under the cord as usual. Following the operation there was extensive wound infection on the left side. About six months later he developed a large ordinary post-operative incisional rupture on the left side coming through the original muscle-splitting incision at least an inch above the position of the

internal ring but never going into the inguinal canal. I heard from his doctor that he subsequently went to another surgeon and was operated upon for rupture.

Here is a case of true inguinal and femoral hernia both on the right side; no hernia at all on the left. Following operation the two herniæ on the right side were permanently cured and on the left, where there was no hernia, the man developed, as a result of wound infection, a typical post-operative rupture.

CASE No. 24—4534.—A man came for operation for left inguinal hernia and had a severe acute "cold" when he entered the hospital. He was kept in bed three days for this to subside. The operation was done in my usual way through a muscle-splitting incision into the general cavity an inch above the neck of the hernia, the sac completely and easily removed, the inguinal canal closed under the cord (Bassini). Promptly following operation he had pneumonia with violent cough and said he felt the inside stitches break. There was no wound infection and no bulging was noticeable when he left the hospital. Six months later he noted a "rupture" and a year or so later returned to me for operation. The operation was performed through the same incision into the peritoneal cavity. There was no neck of hernia but a separation of the edges of the peritoneum at the previous point of suture. The edges of the peritoneum were easily freed, brought together and resutured and the inguinal canal was reclosed under the cord (Bassini). The cure was permanent.

This was a case of true post-operative rupture from suture breakage incident to post-operative pneumonia.

CASE No. 26—5552.—A young man came for operation for recurrent bilateral hernia. He had been operated upon elsewhere two years previously, both wounds were followed by extensive suppuration and in six months following the operation he had a "recurrence" on each side. When first noticed they were of small size but gradually grew until the left side was nearly the size of an adult fist and the right side somewhat smaller. The operation for the "recurrence" was done through the usual muscle-splitting incision into the peritoneal cavity an inch above the neck of the hernia. On both sides there were found typical hernia necks such as we see in practically every case of indirect hernia. The original herniæ had not been removed. There were no adhesions. The peritoneum of the general cavity extended an inch into the canal on each side; beyond this there was found the fibrous tissue sac which goes with every post-operative incisional rupture of more than a year's standing. I excised from above one inch of redundant peritoneum around the neck of each hernia and removed the sacs, pulling them up from within. Both canals were re-closed by suturing the upper leaf of the aponeurosis to the shelving edge of Poupart's ligament under the cord, using a fascia suture on the left and catgut on the right. After removal the sacs were examined and the points of junction of the true peritoneum with the fibrous tissue sacs were easily seen by the naked eye.

This was a case of combined incompletely removed hernial sacs and post-operative incisional rupture.

CONCLUSIONS

True abdominal hernia is peritoneal sac formation resulting from anatomic growth, *i.e.*, congenital. This concept of hernia is well nigh universal. And yet in discussing the subject even with surgeons, one is forced to wonder if the full significance of this belief is adequately comprehended. A finger,

an appendix vermiformis, a hernia; any anatomic formation once removed, never reforms.

"Recurrent hernia" represents the incompletely removed original hernia, or the development of incisional rupture following breakage of sutures or tissues by coughing, vomiting or wound infection. This conception of recurrence makes clear the fundamental principles involved in its prevention and cure. The surest way to avoid the need of a second operation to remove a hernia is to remove all the sac and redundant surrounding peritoneum at the first operation. I have described an extremely simple, safe and efficient method of accomplishing this and have employed it in more than twelve hundred cases. An incision is made directly into the peritoneal cavity above the hernial orifice giving a good exposure of the neck of the sac, the surrounding loose redundant peritoneum and neighboring structures. By this method one is enabled to study the anatomy of the hernia and the region involved with a satisfaction vastly superior to the old method of isolating, pulling down and removing the sac from the outside and with no danger to neighboring structures. A circular incision is made through the peritoneum above the hernia enabling one with great ease to pull the entire hernia up out of the canal and scrotum and to know at the conclusion of the operation that the entire hernia is removed and the peritoneum sutured one or two inches above the orifice of the inguinal canal.

For the cure of a hernia which has been operated upon but not removed, the operation consists chiefly in the removal of the hernia and the surrounding peritoneum and this can much more easily be done through a muscle-splitting incision one inch above the inguinal canal above the scar tissue of the previous operation in exactly the same way as is described above. For post-operative incisional rupture the same operation from above gives easy access and facility for suture of the hole in the wall. The inguinal canal, greatly enlarged as a result of tissue sloughing, had best be repaired by the suture implantation of fascia from the external oblique by the method of McArthur or from the thigh according to the method of Gallie.

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RECURRENCE AFTER OPERATION FOR OBLIQUE INGUINAL HERNIA IN THE ADULT MALE

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The recurrence of oblique inguinal hernia has been variously estimated over a long period of years. Statistics published by many operators from various clinics indicate a rather wide differential in the percentage of unsuccessful operations.

In 1923, Erdman [1] reported 21 recurrences, 3.15 per cent., in 665 operations for oblique inguinal hernia in males. In 1918, W. B. Coley and Hoguet [2] reported the results on a series of 6090 operations for hernia at the Hospital for Ruptured and Crippled. Of this number, 4420 were for oblique inguinal hernia in the male. There were 25 recurrences—5.7 per cent. In 1923, Hoguet [3] reported sixteen recurrences, 1.6 per cent, in 963 operations of indirect inguinal hernia in males over fifteen years of age. In 1924, B. L. Coley [4] reported 28 recurrences, 8.7 per cent., in the 332 patients who reported after 1155 operations for indirect inguinal hernia in the adult male.

It is evident from this selected statistical data that opinion regarding the recurrence of inguinal hernia is at variance. Not only do different authors vary in the percentage of failures reported, but the same authors, reporting at different times, give widely different figures.

It has frequently been stated that a patient, unsuccessfully operated upon for hernia, will not return to the surgeon or clinic responsible for the operation, but will seek relief elsewhere. This fact has been emphasized from time to time and held responsible, in a measure, for the small number of recurrences reported from certain clinics. This may or may not be an accurate statement. Assuming, for the sake of argument, that a majority of these patients do seek relief elsewhere, it is logical to deduce that the law of averages would bring approximately the same number of recurrences to each clinic. Eventually, therefore, they would all find their way into statistical data; and "statistics can be made to tell anything—even the truth."

In limiting this survey to the indirect type of hernia occurring in the adult male, we feel that it offers a basis for constructive reasoning. These operations were all done between January, 1921, and January, 1926, at the New York Post-Graduate Hospital, on the service of Dr. Charles Gordon Heyd. They were performed either by Doctor Heyd or myself, and the Bassini technic, or some modification of it, was used in each instance.

In this series, letters were sent to 576 patients, and 148 were returned by the post office because the individuals could not be located. Four hundred and twenty-eight letters were apparently delivered, and there were 266 replies

received. An uncertainty, as to whether or not a cure had been effected, rested in the minds of 48 patients. They all accepted the invitation for a free examination to clear up this point.

There were two deaths in the series; one due to pulmonary embolus and the other to lobar pneumonia. There were 258 cures, and 6 recurrences—2.255 per cent. Two of these were at the internal abdominal ring and four at the external abdominal ring.

While the percentage is lower than that reported by some operators, it is somewhat higher than that reported by others. It is slightly better than the average of the recurrences reported by twelve different surgeons during the past ten years.

Of the many causes for the recurrence of hernia, infection is, perhaps, the most frequent. In the presence of pus-producing organisms, there is the sloughing of tissues, the very early dissolution of the suture material, and a wide separation of the structures recently approximated. It is then only a matter of time—and generally a very short time—until the bulge in the inguinal region is larger than before operation.

Closely allied to infection, but of less importance, is the lack of complete hæmostasis. A moderate or large size collection of blood in the inguinal canal can, by purely mechanical means, so distort the structures as to prevent a proper union, and subsequently permit a new sac and its contents to protrude. If such a hæmatoma fail to produce a recurrence mechanically, the probability of a superimposed infection is ever present.

The higher the ligation of the sac, the more likely one is to effect a cure, and vice versa. When the neck of the sac is ligated and the suture cut, it should slip into the abdominal wall and disappear from view. This, of course, predicates a meticulous and complete freeing of the neck of the sac from all the surrounding tissues. If this procedure be not properly executed, a recurrence is present before the operation is completed.

Moschcowitz and Erdman have reported recurrences due to the slipping of the ligature or suture from the neck of the sac. It must be apparent that this accident can occur. Secondary operation, in such a case, would reveal the hernial contents without a sac and covered only by loose fibrous tissue.

The internal oblique muscle must be thoroughly mobilized and easily approximated to Poupart's ligament. If this be not the case, then undue tension will be made to slide the muscle into position. This will result in a partial or complete strangulation of the fibres involved. There will then be no union, or only a weak fibrous one, between the internal oblique muscle and Poupart's ligament. If, under the undue tension, union does take place, it is likely to do so at the expense of a split in Poupart's ligament. Either of these two factors quite easily leads to a recurrence.

Persistent vomiting is reported as an important cause of recurrence. The writer has had no experience along this line, but he would not be inclined to feel that vomiting alone could be responsible for recurrence. With contributing factors, however, such as poor musculature, improper transfixion of the

sac, etc., it would seem perfectly possible for violent vomiting to furnish the final strain to destroy the repair. The proper application of adhesive straps, which, within limits, fix the abdomen, will generally take care of considerable strain due to excessive vomiting.

Poor musculature—especially a slender, anæmic-looking, fat-streaked internal oblique—is a definite and important cause of recurrence. In the face of an inadequate internal oblique muscle, something further than the usual type of operation should be performed. If this be not done and a recurrence results, then the cause should be laid to a lack of surgical judgment.

Accidental injury to the ilio-hypogastric nerve, resulting in paralysis of the internal oblique muscle, is reported as an important cause of recurrence. This explanation hardly seems tenable in face of the experiments of Edmund Andrews [5] proving that "all the motor fibres are given off before the nerve (ilio-hypogastric) enters the field of operation for hernia, and that, therefore, accidental section of this nerve will not cause any paralysis of this muscle."

Any acute infectious disease, particularly pneumonia, occurring soon after operation, has a deleterious effect upon the recent repair. Any absorbable suture material will dissolve more rapidly in the face of a general infection than under normal conditions. Such an infection, therefore, must be looked upon as a definite contributory cause of recurrence.

During the past few years, stress has again been laid upon the fact that suturing the internal oblique muscle to Poupart's ligament is based upon unsound principles. Oudard and Jean [6] go so far as to state that the Bassini operation should be abandoned. Recommendations vary from a fascia to fascia approximation (Seelig and Chouke),[7] to the use of strips of fascia or living tissue for suture material (McEachern).[8] The consensus of opinion, however, seems to be that these views are rather exaggerated and the resultant recommendation to be used only in selected cases. As referred to earlier in this article, an anæmic, fat-streaked muscle will need more than the usual Bassini repair if a cure is to be hoped for. For the usual type of case, the approximation of muscle to fascia seems to serve admirably.

The repair of an inguinal hernia is generally quite simple. Every surgeon worthy of the name has done hundreds of them. For these two reasons, it is generally this operation that falls as the first fruit of his endeavor to the house surgeon. This is both logical and just, for we have all had to do our first herniotomy. But we must not overlook the fact that this is probably an important factor in judging the causative agents of any unduly large percentage of recurrence. I do not know that this factor has been previously referred to by anyone.

We are of the opinion that the Bassini technic for the repair of inguinal hernia is applicable and sufficient in the vast majority of cases. In the aged, where the musculature is weak, and in individuals with anomalous conditions, the Bassini technic, together with one or more of the numerous recommended modifications, will suffice.

A concentrated effort at perfection with the Bassini operation will, we

believe, give much better results than the continued search for a new technic. It has stood the test for forty years. It has been performed under all conditions by countless operators with a wide range of experience—from none up. In the face of this, we think the percentage of recurrence to be very low, perhaps not much greater than one would expect, taking into consideration the human equation.

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THE SURGICAL SIGNIFICANCE OF THE RECTO-SIGMOID SPHINCTER*

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and

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In certain portions of the alimentary canal the onward passage of ingesta is habitually delayed. This delay, having its obvious physiological purposes, is caused by a localized tonic contraction of the encircling musculature of the gut; and is so correlated with segmenting and propulsive peristaltic movements that when the purpose of the delay has been accomplished the constricting fibres are inhibited, and the visceral content is thrust onward.

Fig. 1.—Location of the recto-sigmoidal sphincter which is about six or seven inches above the anus.

A sphincter muscle is habitually in a state of tonic contraction incident to the control maintained by its intrinsic ganglia; accentuated or inhibited by its sympathetic and parasympathetic nerve supply. Irritation either direct or reflex increases its tonus.

It is not completely competent against continued pressure of fluids.

Its hypertonus may cause pain as may the hyperperistalsis developing in the effort to overcome the resultant obstruction. This pain may be severe, is usually intermittent, is referred to or about the seat of muscular spasm.

The stasis caused by a persistently hypertonic sphincter may be relieved by overstretching or by section of the muscle at fault.

Hypertonus of the cardiac sphincter (cardiospasm) may be so pronounced and persistent as to cause œsophageal dilatation and death by inanition. It is cured by overstretching this sphincter.

The infantile form of hypertonus of the pyloric sphincter in its grave

* Read before the American Surgical Association, May 13, 1927.

form causes death by dehydration and starvation. If inhibition does not develop under proper diet, it is cured by cutting the sphincter.

The pyloric hypertonus of the adolescent and adult, a common cause of chronic indigestion, dating from infancy, has many times been cured by overstretching or by cutting the sphincter.

Hypertonus of the recto-sigmoid sphincter, causing that enormous dilatation of the sigmoid and colon called Hirschsprung's disease in the infant and adolescent, megalocolon in the adult, by analogy may be cured by cutting or stretching the sphincter.

The sigmoid colon, beginning on the left side at the crest of the ilium and terminating opposite the third sacral vertebra; with a parietal mesenteric attachment of three and one-quarter inches and a visceral one of nineteen, has the widest range of motion of all abdominal viscera. It usually occupies a pelvic position, its distal end forming an acute angle with the fixed rectum. The The recto-sigmoid sphincter is situated just proximal to this juncture.

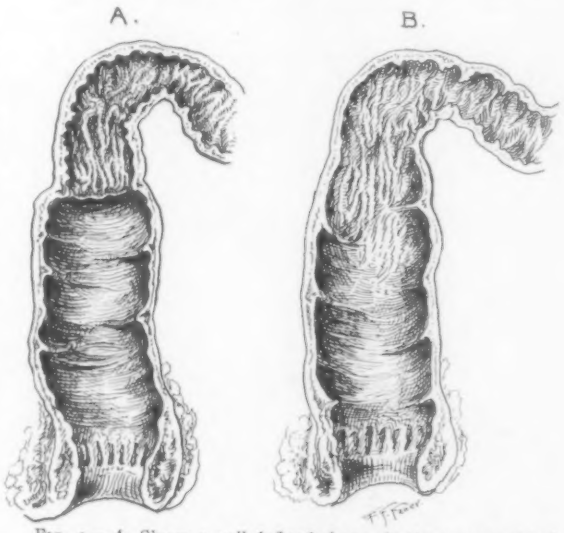

FIG. 2.—*A*. Shows a well-defined change in the appearance of the bowel at the recto-sigmoidal juncture which is similar to that at the gastro-duodenal juncture. It is found in only a small percentage of cases. *B*. Shows the more common appearance of this region in which the transition from sigmoid to rectum is more gradual.

As a rule the sigmoid has a well-developed musculature exhibiting no local increment of circular fibres to suggest an anatomic sphincter, nor a constant perceptible narrowing at the recto-sigmoid juncture. In the opened bowel (31 specimens) 12 showed a distinct and abrupt transition in the appearance of the mucous membrane between sigmoid and rectum similar to that at the pylorus, and a distinct narrowing at this point. This change was not seen in the remaining cases nor did it always coincide with the recto-sigmoid juncture, but varied from a distance of four centimetres to thirty-one centimetres from the anus.

In the sigmoid occurs the final delay preceding the act of defecation. Until the rectum is perverted by habit, material in bulk within its lumen excites the desire to expel it. When the contents of the sigmoid pass into the rectum through an inhibited sphincter, adequate defecation may empty not only the rectum and sigmoid, but the colon as well.

The form of recto-sigmoid sphincterismus known as congenital idiopathic dilatation of the colon or Hirschsprung's disease, becomes manifest in the early weeks or months of life by obstinate constipation, great enlargement of the abdomen usually beginning on the left side, visible peristalsis and pro-

gressive emaciation and weakness. In cases where efforts to empty the colon have been successful, the individual may live to adult age subject to periods of prolonged constipation with enormous distention of the abdomen. The rectum is usually empty and röntgenograms made after an opaque enema show great dilatation of the gut.

More than 400 cases were reported up to 1918, and various types of operation have been and are being performed, having in the main for their object removal of the colon.

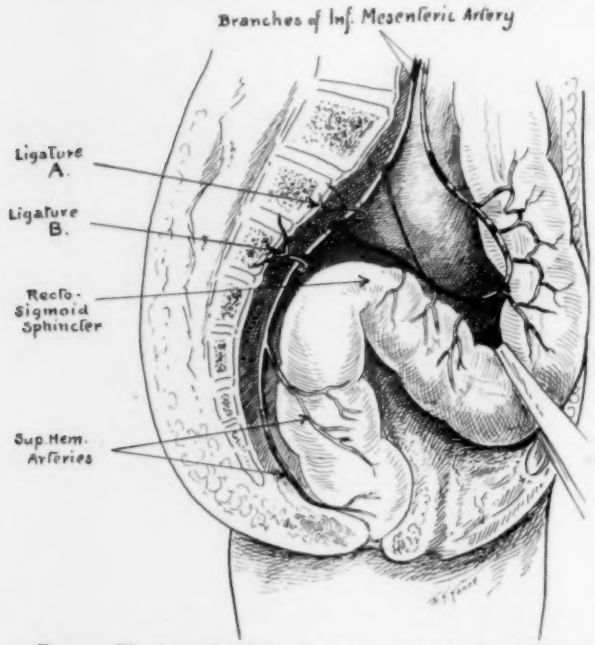

FIG. 3.—Blood supply of sigmoid and upper rectum from inferior mesenteric artery. Ligature at *A* is safe because collateral circulation is readily established. Ligature at *B*, in the event of destruction of the middle and inferior hemorrhoidal branches will cause gangrene of the upper rectum and lower sigmoid because of the absence of collateral circulation. (Taken from Hartman, ANNALS OF SURGERY.)

Operative findings and pathological examinations of removed specimens show an enormous sigmoid with thick muscular walls, the dilatation ending abruptly at the recto-sigmoid junction. There are no other significant changes, hence the condition must be due to obstruction at this point, nor is there any way of accounting for this other than muscular spasm; rendered more effective by the sharp angulation and overfilling of the gut at this point.

The operation here recorded was based on this belief.

A child three years old was admitted to the hospital with a greatly distended abdomen. He had been obstinately constipated from his third month. The swollen belly was noticed when he was about seven months old. Fluoroscopic examination showed a huge sigmoid, which on operation resembled an adult stomach, the dilatation terminating at the recto-sigmoid junction. A rectal tube was inserted past this junction and a one-and-a-half inch longitudinal cut made over the seat of narrowing down to the mucous membrane which was allowed to prolapse.

Four months later the child was discharged from the hospital with no palpable or visible evidence of dilated sigmoid. Two months later he died of tuberculosis and was autopsied by Doctors Moffitt and Coover, who noted that the ascending colon, transverse colon and upper portion of the descending colon were large and about the size of those of an adult. The lower portion of the descending colon and sigmoid were more nearly normal, but the walls were very thick. The marks of the operation were scarcely visible.

The following case, typical of the adolescent and adult form of megalocolon was apparently cured by an auto-dilatation of the recto-sigmoid sphincter.

An eighteen-year-old boy was admitted to the hospital, complaining of generalized abdominal pain, beginning on the left side which had lasted for two days and was accompanied by recurrent attacks of vomiting. He had not had a bowel movement for three days. The abdomen was greatly distended, rigid, tympanitic and tender over both lower quadrants. The white blood-cells numbered 13,000.

Operation revealed a large fecal impaction which was removed by combined intra-abdominal and rectal manipulations.

He was re-admitted to the hospital two years later in much the same condition as before; and again five months later. On both occasions the condition was relieved by repeated copious enemas which resulted in the passage of enormous amounts of fecal matter.

About two months after his last visit to the hospital his abdomen again became distended, but he obtained relief at home by large enemas which brought away about ten quarts of fecal matter, some of which was in large masses almost the size of a grape-fruit.

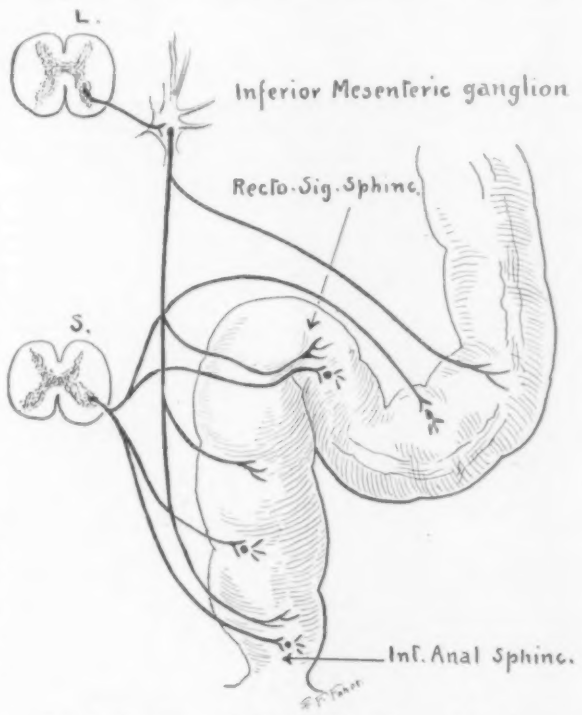

FIG. 4.—Nerve supply of lower sigmoid, rectum and recto-sigmoidal sphincter showing the double source of innervation from the sympathetic and para-sympathetic divisions.

The patient was examined two years later and stated that he had been perfectly well since his last experience, had been working every day as an electrician and had a normal daily bowel movement. He was well developed, muscular, and there were no abnormal findings by abdominal and rectal examination. This patient had suffered from obstinate constipation and from bloated belly since early childhood. There were frequent periods when he would go without a bowel movement for a week or perhaps longer.

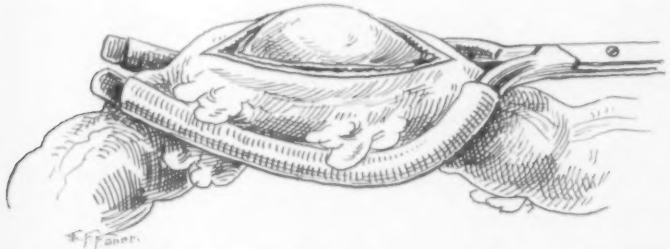

FIG. 5.—Longitudinal section of the bowel down to the mucosa which cuts across the circular fibres of the sphincter and allows the mucosa to bulge into the wound. (Adapted from the Rammstedt operation.)

The probable explanation of cure is through the over-stretching of the recto-sigmoid sphincter, by the passage through it of large fecalomas.

Procedure of Treatment.—For the ambulatory patient the best position is the knee-chest; for the case of Hirschsprung's disease, the knee-chest, left lateral or perineal position; for post-operative distention, the left lateral or perineal position.

With the patient in the proper position the proctoscope is passed with the aid of sight and air distention to the lower sigmoid. The dilating apparatus, well lubricated, is passed through the proctoscope and placed in the recto-sigmoid sphincter. The proctoscope is now withdrawn and the bag fully inflated by air under 160 mm. of mercury pressure. Overdistention of the bag is prevented by the silk covering. The dilatation is without pain and causes only slight discomfort in the lower abdomen. The apparatus is allowed to remain for ten to twenty minutes, is then deflated and withdrawn. For relief of post-operative distention a colon tube under guidance of a proctoscope is passed through the sphincter into the sigmoid and the distention thereby relieved. The anal sphincter also may be stretched by the dilating bag.

FIG. 6.—X-ray photograph of dilating apparatus in position in the recto-sigmoidal region. The light shadow indicates the outline of the distended bag.

The apparatus consists of a proctoscope with the usual accessories, and an inflating bag. The dilating instrument consists of a rubber bag mounted on a colon tube in the lumen of which is a flexible metal rod carrying a metal olive tip which facilitates passage of the instrument. The dilating rubber bag is covered by a silk bag which limits the degree of dilatation.

SUMMARY

In the absence of a demonstrable lesion, persistent tonus at the recto-sigmoid sphincter is the usual cause of sigmoidal stasis. This stasis may be expressed as in Hirschsprung's disease of the infant, as obstinate constipation and ultimate megalocolon in the adolescent or adult. It may further be expressed in the form of post-operative tympany, unrelieved by tube or enema.

The palliative treatment of sigmoidal stasis is based on measures designed to make or keep the bowel contents fluid, strengthen peristalsis, and relax the tonus of the sphincter muscle. Laxatives and purgatives given by the mouth and copious enemata keep or make the sigmoidal content soft or fluid

and stimulate peristalsis. Belladonna derivatives relax spasm as does magnesium sulphate; the latter given in the form of an eight ounce enema of the saturated solution.

Chronic sigmoidal stasis with or without hypertrophy and dilatation of the gut may be cured by cross-cutting the recto-sigmoidal sphincter, allowing the mucosa to prolapse into this muscle wound without effort at plastic closure. Or the sphincter may be overstretched by means of a Plummer bag, or larger diameter than that used in the œsophagus, passed through a proctoscope.

Insofar as the colon is concerned post-operative tympany may be relieved by passing a colon tube into the sigmoid, guiding it through and past the recto-sigmoid sphincter by means of a proctoscope. Rivas has successfully passed such a tube, made soft by boiling, by the sense of touch, and has X-ray pictures to prove that it can be done.

CHRONIC SYNOVIAL TUBERCULOSIS*

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The conception of joint tuberculosis as a disease of bone in its essential pathology has found almost universal acceptance and is uniformly maintained in almost all pathological texts. Such very extensive studies as those of Fraser would almost seem to remove the subject from the field of dispute, as well as to further establish the proposition that invasion of the joint is invariably from a juxtachondral osseous focus, with synovial involvement, however widespread, a secondary phenomenon beside which bony lesions continue to progress as the essential pathology of the joint. Though less well supported by the evidence of pathological material, in some quarters a belief in frequent primary synovial invasion with only secondary involvement of osseous joint tissues still persists.

Quite as certainly in the minds of many clinicians there has persisted a conviction that both primary and chronic limitation of tuberculous pathology to the synovial and chondral tissues frequently occurs. In most instances this impression may have been based on an empirical foundation only; such as the observance over a considerable period of time of arthropathies believed tuberculous on various clinical grounds, which persistently failed to show by X-ray evidence of bone involvement, and finally recovered with preservation of both motion and function. Such instances have lacked confirmation of diagnosis by such positive evidence as microscopic section, and though occasionally supported by the guinea-pig inoculation test, seemed to have been mainly in smaller children where a bone focus cannot certainly be ruled out by X-ray and where occasionally cures can be expected under conservative treatment.

In the last few years several contributions to the literature, based on operative findings in early cases of joint tuberculosis, have emphasized definite synovial involvement without X-ray, gross, or microscopic evidence of a bony lesion. Rogers,† in 1922, reviewing such cases from the Clinic of the Massachusetts General Hospital, after emphasizing the outstanding pathological work of the past on bone tuberculosis, concluded that an alternative conception of primary synovial disease must also be accepted. In many instances his clinical evidence was not entirely conclusive; some of the cases were so early that a small bone focus might still not have developed to a degree where it could not be missed. The preponderance of discussion of this paper when presented before the American Orthopædic Association in May of that year was distinctly against his proposition.

* Presented at the Clinical (Central States) Orthopædic Society, November 5, 1926.
† Rogers: Journal Bone and Joint Surgery, vol. xx, April, 1922, p. 679.

The writer's own clinical impression from cases seen at the same Clinic in the years just preceding, had remained in accord with the classical conceptions of this disease, and had not been modified by subsequent clinical experience, until early in 1926, when by a strange coincidence there came to radical operation five cases of very long-standing joint disease in whom no osseous pathology could be found, though with indisputable microscopic evidence of synovial tuberculosis of long duration. It seemed that our previous convictions must be revised; and accordingly we noted with considerable gratification the conclusions in Smith's ‡ comprehensive and scientific study of the pathology of joint tuberculosis as seen in Hibb's Clinic, New York, appearing in *Archives of Surgery* in May, 1926.

FIG. 1.—Case I. A. P., film of Röntgen examination, just prior to operation. Note excellent preservation of joint space and absence of decalcification. The roughened appearing lateral aspect of condyle of femur was examined particularly at operation and found to represent two irregular ridges, one at anterior and one at posterior margins of lateral surface where the latter joined the trochlear articular cartilage. There was no destruction of bone, but rather a proliferation process. Röntgenologist's diagnosis: Hypertrophic arthritis.

In this most excellent contribution a thorough review is made of important previous pathological investigations, and though a little of this work had been in favor of primary synovial disease, the weight of evidence had been strongly in favor of a bony pathology at the start. In the experience of that Clinic, on the contrary, most of the operated cases seemed to show synovial lesions only. Children predominated, and the adoption of the policy of early diagnosis by explora-

‡ Smith: Archives of Surgery, vol. xii, March, 1926, p. 740.

tion, with fusion following in the event of positive diagnosis of tuberculosis, had caused duration to be short in many. Still, Doctor Smith was able to collect a series of seventeen cases with an average duration of eighteen months, all proved at operation to have exclusively synovial lesions. Eight of the seventeen were under ten years of age and only three were adults. In two patients the duration was four years and in one five.

It had seemed to the writer that on such evidence as the latter—that is to say, adults with duration of years—that the brief for chronic synovial tuberculosis must mainly rest. When progressive synovial involvement has lasted in an individual for several years and no bone lesion has developed which can be recognized either by X-ray or by the gross pathological findings of a radical operation, the additional suggested criterion of consecutive millimetre sections of the entire epiphysis of all the bones of the joint may reasonably be excepted. Of course, argument may be raised as to the fallibility of evidence of duration of disease, and the possibility that shortly before operation a tuberculous infection may have become engrafted in a rheumatoid or traumatic arthritis. It can only be said that in the recent experiences of the writer the microscopic study of the synovial pathology indicated a definitely chronic tuberculous process. We have frequently explored cases of comparatively short history and found limited and rather recent appearing synovial pathology. Although these were usually devoid of obvious osseous pathology, this evidence was considered of much less weight than that of the five cases to be described.

FIG. 2.—Case I. Low power microphotograph of synovial section, showing on one hand fibrosis and on other extensive infiltration by round and wandering cells with many giant cells and in places areas of coalescence into large foreign body giant cells and typical tubercles.

The five patients in this series were all adults who had had constant symptoms in the joint for from three to seven years. All had X-rays which we had considered negative for bony lesions, and all came to radical operation, excision and fusion being performed in three, and, for reasons which will appear below, synovectomy in two.

From the many microphotographs and skiagraphs submitted by the author to illustrate the conditions found in these cases, certain ones only have been selected for reproduction as types.

CASE I.—R. H., Case No. 71,671, a white male of twenty-six years of age, was registered in the Clinic in January, 1926, with the following history: Three years prior was kicked on the left knee by a cow, the knee at once becoming painful and swollen, but without complete disability and gradual amelioration of symptoms. Knee was never considered normal after this as some swelling soon recurred and intermittent periods of pain and considerable lameness, generally relieved by rest, and always free from pain at night and when not on his feet. Any sudden step or twist always brought an exacerbation, and a loss of complete extension had been gradually increasing since first injury. Three days prior to admission he had sustained an especially severe wrench with rather severe pain and increase in the swelling always present since first injury. Walking has been possible since only with marked limp and considerable discomfort. General condition had been good with no loss of weight or feverishness. Past history revealed nothing of importance save that he had had "chronic hip disease" in childhood and that arthrodesis had been performed on this hip at age of fifteen with no trouble since.

The physical examination generally revealed nothing of importance save bony ankylosis of the right hip in optimum position. (This hip had been operated by Doctor Hoke, of Atlanta, Ga.) The lungs were negative. The general nutrition was excellent. There was no local or general adenopathy. Temperature was normal. Routine blood Wassermann and urinalysis were negative. There was considerable constitutional reaction, definite increase in knee symptoms and elevation of temperature following subcutaneous injection of 0.5 mgm. of old tuberculin. Röntgenologist's report of X-rays of knee here shown follows: Antero-posterior and lateral view of the left knee. There is a distinct evidence of hypertrophic osteo-arthritis involving the bones comprising the knee-joint. There is, however, no definite evidence of bone injury.

Local examination on admission showed slight generalized enlargement of joint, moderate quadriceps atrophy, no atrophy of calf, no erythema or skin pigmentation; to palpation there was questionable local heat, moderate but quite definite synovial thickening and loss of elasticity, no ballottement of patella but possible fluctuation; tenderness was quite marked below patella, particularly at mesial aspect of joint line. Motion was executed readily though carefully with range from angles of 165 to 90. No crepitation audible or palpable was observed. Motion seemed to be checked by mechanical resistance rather than by spasm.

Pre-operative diagnosis of probable traumatic arthritis from internal derangement was held, but on account of the tuberculin reaction exploration was advised and performed on January 20, 1926. On diagnosis by microscope of tuberculosis, fusion of the knee was performed. That part of operative note including operative findings is quoted herewith:

"*Operation.*—Stockinette is clamped to the skin margins; all veins in subcutaneous tissue identified before division and tied. The quadriceps fascia and capsule are incised and a thick layer below it encountered; several deep plunges with knife made toward the centre of the joint in an effort to allow the escape of a portion of joint fluid for specimen, fails to penetrate the free cavity. The development upward finally reveals a free cavity in the quadriceps bursa. Thickened alar ligaments and apparently granulation tissue completely fills up the intercondylar space and the dissection has to go practically into the notch before free joint fluid is found. This in no way resembles joint fluid but more like very thin, old blood. Specimen obtained for diagnosis.

"*Pathology.*—As the dissection proceeds, presenting conditions are as follows: A very marked avascular thickening of the synovia in the region of the quadriceps bursa, a more vascular infiltration of the lining of the joint below, which is adherent to the edges of the condyles resembling pannus but much tougher and more fibrous than usually seen in tuberculosis; over the front of the condyles along their ridges there is no evidence of bone necrosis but on the contrary of bony proliferation. This pannus, adherent to the cartilaginous surface of the intercondylar region, solidly fills up the notch and has overgrown the cartilaginous surface of the condyles for a little way in from either side."

In addition to resections for fusion the joint was completely luxated and synovial

membrane carefully dissected completely from both anterior and posterior compartments, but everywhere exposing intact cortical bone. The bone sections from femur, patella, and tibia revealed no areas of central necrosis.

Following is report from Pathological Department on hardened sections:

"The specimen consists of several thin pieces of cancellous bone removed from knee-joint. Some are covered with the joint cartilage and can be identified as those of tibia. The cartilage surfaces are finely roughened, the synovial membrane is apparently replaced by pale brown, soft, fringy overgrowth. In the bone no macroscopic changes are seen.

Sections show the synovia infiltrated throughout by round and wandering cells with many whirls of epithelioid cells scattered throughout. In the centre of most of these whirls we see typical foreign body giant cells so that they form typical tubercles. The lesion seems to be of the productive type since no destruction or necrosis is found. Diagnosis: Tuberculosis. The patient made an eventful convalescence, returning to his work as electrician three months after operation. Final examination nine months after operation showed bony ankylosis in position of 15 degrees flexion, no varus or valgus.

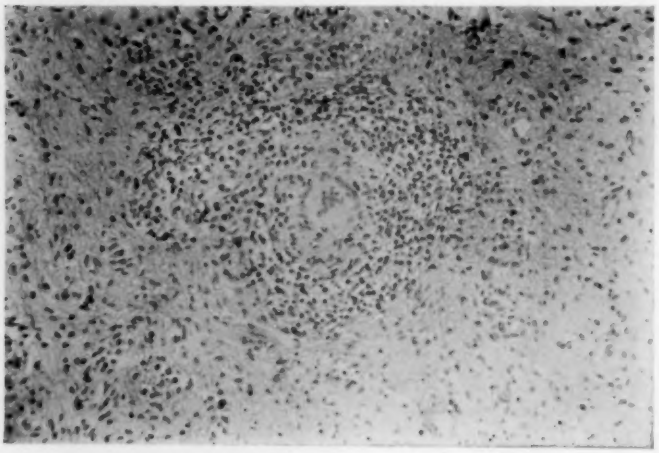

FIG. 3.—Case II. One of many typical tubercles found in synovial membrane.

CASE II.—J. V., Case No. 70,187, white male, aged thirty-one, registered in the clinic in November, 1925, with following history: Seven years prior with no definitely recalled injury began to limp with pain at inner side of knee. Shortly after was in bed six weeks with pneumonia and pleurisy and at end of that time knee seemed to have recovered. In a few weeks began to be occasionally a little lame after exertion and sometimes accompanied by moderate swelling. Five years prior bumped knee slightly with rapid development of pain, swelling and limitation of motion. Plaster cast was worn for one month and followed by physiotherapy with considerable improvement though swelling never entirely left, knee never became quite straight nor could it be bent beyond a right angle without pain. Two years prior there was another acute exacerbation of symptoms after moderate strain and ever since these have been recurring with increasing frequency and with progressive limitation of range of movement after each. Lately has been using cane with some improvement in symptoms. Has never any pain at night or while off his feet, and no feverishness or chills associated with exacerbations. General health has been good, no loss of weight, present weight being within a few pounds of normal. Has regularly kept up his profession as attorney.

General examination showed nothing of importance. Chest was negative and there was no adenopathy, general or local. Examination of the knee showed marked enlargement but this in main involved the mesial pouch of quadriceps bursa and with leg held slightly externally rotated at knee, gave an appearance of considerable valgus. There was marked quadriceps atrophy but no atrophy of calf. There was no erythema but a rather definite yellowish tinge to skin. Local heat was questionable, but to palpation there was definite fluctuation though the patella was not floating. There was slight generalized synovial thickening. Range of motion was between 165 and 100 degrees

accompanied by a grinding sensation. There was marked excess lateral mobility but considerable pain if any manipulation was attempted.

Temperature was normal. Blood Wassermann and routine urinalysis was negative.

X-rays of knees, shown here, indicated some absorption of joint cartilage and thickening of soft parts but no erosion, defect or localized increased radiability of bones. Röntgenologist's diagnosis—arthritis.

Tentative diagnosis of chronic hypertrophic synovitis from internal derangement was held but for some apparently instinctive reason the writer advised preliminary exploration under local.

Operation was performed February 13, 1926. The exploratory incision revealed extensive synovial pathology with immediate report of tuberculosis on frozen section. Arthrodesis was at once recommended and vigorously urged but patient steadfastly refused to consider any operative procedure designed to stiffen the joint though he would agree to any other intervention with fusion to fall back on later if necessary. Accordingly a complete synovectomy was performed. The incision was widely extended after the manner of Timbul-Fisher, the entire ends of tibia and fibula delivered through the incision and both posterior and anterior compartments thoroughly explored and cleaned out. Throughout the pathology was found confined to synovia and cartilage and no break in integrity of cortex of either bone was revealed. The operator's dictation was as follows:

"*Pathology.*—A most interesting and unusual pathology is revealed by the extensive opening of the joint obtained through the long incision. Everywhere the synovial membrane is thickened, œdematous, grayish, and less injection of blood-vessels than usually seen. Almost everywhere, except in the quadriceps bursa, the endothelial lining has been replaced by a low-grade granulation tissue, typically pannus in appearance, but with the impression of decreased vascularity. In the notch, however, the congestion is more active and the granulation tissue more typically tuberculous. On the other hand, the alar ligaments are extremely large, are perfect in their morphology and otherwise differ only in a lemon tinge instead of the golden yellow. The trochlear surfaces are markedly encroached upon both sides of the notch by pannus formation destroying the cartilage from the borders centrally. The same is true with the articular surface of the patella, the peripheral 50 per cent. being eroded. The erosion is inconsiderable on the tibial condyles but the internal meniscus is completely absent or at the most only a fibrous strand adherent to the capsule, represents this former structure. The external meniscus is completely detached from the tibia but adherent to the capsule and is markedly atrophied. Part of the quadriceps bursa was obliterated. Extreme bulging at the antromedial aspect of the knee, which was thought to be a hernia of the synovial membrane and capsule from hydrops, turns out otherwise. There is decreased fluid in the joint and there is found at the point of this bulging an extra-capsular pocket which seems to be caused by an old obliterated sinus of the quadriceps bursa. This pocket is about as large as a small lemon, at the inner side of the knee it communicates with a larger one which extends up along the medial aspect of the femur between the adductor and quadriceps groups half way to the hip. This dead space is filled with semifluid mass in which free fluid is very small in amount and is oily rather than pussy, but the bulk of the contents consists of short worm-like pieces of pale yellow jelly-like material not altogether different from an early fat necrosis. It slightly resembles, but not very closely, the detritus seen in cold abscess, extra-articular, of other joints. Enough of this stuff is milked out to make up a bulk of about one pint. During the course of the radical dissection it became possible to explore the articular surface everywhere with the single exception of the most posterior aspect of the condyles. Nowhere was any bone necrosis observed and the pannus when scraped away reveals hard cortical bone."

Convalescence from operation was satisfactory enough in view of conditions, though as expected pain, sensitiveness and muscle spasm made impossible any early movement that would have made for recovery of mobility in the knee. Temperature was slightly

elevated in first week but normal thereafter. After about ten days wound broke down in centre with sinus formation discharging typical tuberculous material similar to that removed at operation. This persisted for about eight weeks. Patient became ambulatory in cast twenty-five days after operation. He has continued since in a leather case, quite content to accept a fixed knee and impatiently awaiting a safe time to have arthrodesis performed. Nine months post-operative X-ray showed no evidence of spontaneous fusion and there was found about 15 degrees motion in knee on examination. Pathological report follows:

FIG. 4.—Case III. Röntgen examination pre-operative, three years after onset of symptoms. A questionable area at postero-mesial aspect of ulna was investigated and found to show atrophy only. Lateral view of this elbow showed joint surfaces very clearly, but has been lost from files.

"Fusion performed December 17, 1926. Operation showed ankylosis of patella, fibrous obliteration of bursæ and most of joint space, nearly complete erosion of cartilage by pannus ingrowth, most of external meniscus absorbed and cortex in outer portion of external tibial surface eroded over an area one inch in diameter. Bone was necrotic through cone-shaped area three-eighths inch deep beneath this with typical caseation. To this observer it was more suggestive of penetration of bone from joint than of vice versa. Otherwise the sectioned subcortical bone was normal. A small collection of the pus was found in thigh at top of old quadriceps bursa.

"Specimen consists of a handful of soft tissue consisting of muscle, fat, synovial membrane and granulation tissue; jelly-like, fatty, yellowish-gray masses; bit of indurated grayish-yellow fat with a small area of more reddish, friable granulation tissue along one margin.

"Section taken from thickened synovial fringes show the same infiltrated throughout by round and wandering cells with many whirls of epithelioid cells. These whirls of epithelioid cells often have giant cells or areas of dirty blue-staining necrosis at the centre, thus forming typical tubercles.

"**Impression: Tuberculosis.**"

CASE III.—L. M., Case No. 69,259, colored woman, twenty-six years of age, occupation janitress.

History.—Three years prior to operation with injury recalled, began to have pain and soreness in left elbow after use, clearing after a week of rest. There were intermittent symptoms ever since, increasing in frequency to three or four weeks and and requiring longer period of rest for relief. Lately swelling and limitation of extension had developed. Never any pain except when using elbow and for short time after, until lately, when after a day's washing it would become too painful to use the next day.

Examination.—Moderate enlargement of the joint but no deformity; no local heat; definite synovial thickening; moderate tenderness; no crepitation; range of motion from 120 to 75 with muscle protection. General examination showed a well-nourished and slightly obese female with findings of chronic tonsillitis and oral sepsis but otherwise essentially negative. Neurological survey revealed nothing suggestive of central nervous system disease. Temperature, 99; blood Wassermann—four plus to Kolmar antigens.

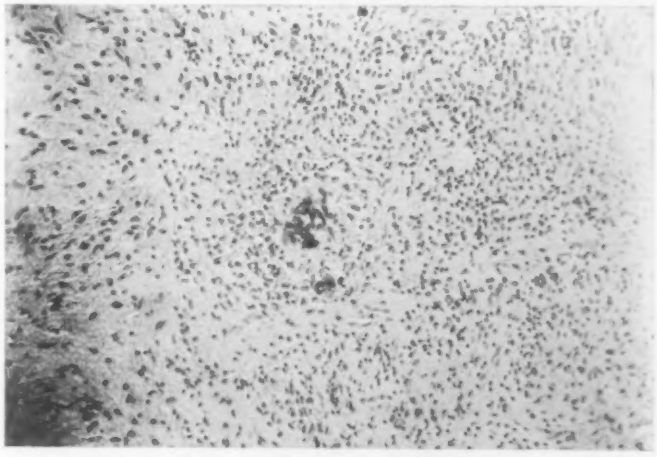

FIG. 5.—Case III. Synovial section showing large foreign body giant cell and typical tubercle in midst of round-cell infiltration.

X-rays were not as clear as could be desired and apparently indicated considerable increase in density of soft parts, but there was no evidence of proliferative activity of bones involved and no areas of decreased density or of fragmentation. Considerable loss of joint space was inferred and some areas of erosion of joint surface. See operative findings in this regard.

The diagnosis most favored was luetic arthritis; however, subcutaneous old tuberculin was given, with a markedly positive constitutional and local joint reaction. Accordingly exploration for diagnostic section was deemed indicated, advised and accepted. On November 15, 1925, under local anæsthesia, a piece of synovia was excised for study. In meantime régime of antiluetic treatment was instituted.

The immediate frozen section report was rather indefinite, no typical tubercles being found. Later hardened sections revealed scattered but definite tubercles and giant cells on more extensive search. Accordingly arthrodesis of elbow was advised the patient.

Operation for this was performed on April 2, 1926. The unusual nature led to a very detailed dictation at that time. Following excerpt covers pathology found present of note:

"*Pathology.*—Present and subsequent dissection seems to reveal a pathological process confined almost entirely to the synovial membrane. This is tremendously thickened throughout, obliterating all the joint spaces; being in the main pale, œdematous, but in places were low-grade granulation tissue and increased vascularity. At the joint surface, pannus formation has extensively eroded the humeral cartilage, but less so on the ulnar and very little on the radius, subsequent bone dissection failing to strike any point of bone pathology whatever. Normal cancellous bone being everywhere exposed.

The impression gained from examination of a very active and extensive synovial process seems to indicate more than usual care in removal of the pathological tissues in

the joint and accordingly a complete synovectomy is done. The lateral ligaments are incised adequately to allow luxation in both directions of the arm and forearm. Line of cleavage is easily found in the deep capsule of triceps bursa and following this round, the thickened œdematous synovia is completely removed from this bursa, from the sides of the joint, from the coronoid bursa and from that surrounding the head of the radius. It is possible to reach every recess and quite certain that complete synovectomy has been done. Excision and internal fixation by beef bone nails was performed."

"*Pathological Report.*—The specimen consists of about one dozen pieces and chips of bone and about 100 grams of ragged grayish bits and pieces of muscle tissue and ligaments. The bone fragments show here and there cartilaginous surfaces some of which are eroded. Some of the soft tissues are pale gray and suggestive of some granulomatous process.

FIG. 6.—Case IV. Synovial section showing early tubercle formation.

"Sections show areas of hemorrhage surrounded by granulation tissue throughout which we see whirls of epithelioid cells often with typical giant cells at the centre forming tubercles. In other areas we see large, pink staining, neurotic masses. "Diagnosis: Tuberculosis."

Immediate convalescence was satisfactory but the sinuses discharged intermittently for several months. At end of six months there was clinically and by X-ray bony ankylosis, and patient was again doing her work as janitress.

CASE IV.—B. D., No. 36,347, white male, age twenty-three years, struck right elbow in October, 1922 (about three and one-half years prior to operation), on an iron beam with immediate pain, and disability followed by slight residual soreness and periodic exacerbations with minor injury. Thirteen months subsequent to onset was examined in this clinic with findings of moderate hydrops of joint and moderate limitation by muscular protection, 160 to 60°. Aspiration advised but patient did not return. Tonsillectomy, later performed without appreciable benefit. Claims he was benefited by chiropractor and returned to work, but symptoms always increased until he laid off for about a week, when he would feel much better. Said swelling was negligible until last six or eight months when it increased with exacerbations and remained more swollen after each. One month before operation quit work on account of increasing pain, but this had almost cleared up at admission.

Physical findings before operation showed a healthy looking young fellow, well developed and nourished, without adenopathy, local or general, and essentially negative physical findings throughout save in the right elbow. The latter was visibly enlarged, particularly in the region of the triceps bursa. No erythema or skin discoloration was evident. To palpation there was no local heat but definite fluctuation, and also a hard resistance back of the condyles, and sensation of generalized synovial thickening. There was little or no tenderness to palpation, there was no relaxation of joint and no crepitation. Extension and flexion were each limited to 50 per cent. of normal, but were not accompanied by muscle spasm or obvious protection.

First X-ray examination on this patient was obtained thirteen months after onset

of symptoms and beyond a slight increased density of soft parts absolutely no pathology could be made out in very clear plates. Films made just prior to operation, three and one-half years after onset, differed only in further evidence of soft part swelling and suggested rarefaction at one side of olecranon. X-ray diagnosis both sets were infective arthritis.

Aspiration of elbow was performed prior to operation and guinea-pig inoculation carried out. As tuberculin test was typically positive both in constitutional and joint reaction, guinea-pig test was not awaited, operation being advised for arthrodesis or synovectomy depending on pathology present. However, it was interesting to note that this pig was negative at eight weeks and that another pig inoculated from operation material died at seven and a half weeks with no evidence of tuberculosis.

Operation was performed January 30, 1926, the joint being exposed through a very long posterior incision allowing wide retraction similar to that in the knee. This allowed a quite complete synovectomy, this layer being shelled from all parts of joint except anterior ulnar compartment, and a bony exploration of the only area at all suspicious in X-ray. On account of the unusual character of case the operation notes dictated at that time were made unusually detailed, and where bearing on pathology, are quoted herewith verbatim:

FIG. 7.—Case V. Lateral view, original of which clearly delineates the entire curve of femoral condyles in spite of the zone of increased radiability at the cortex.

"As the distended triceps bursa is punctured there escapes joint fluid in considerable amount and normal in appearance, except for increased viscosity. With the escape of joint fluid there delivers itself from the aperture a large mass of loose fibrous material which has a somewhat granular or streaked surface, is irregularly quadrilateral about ¾ x 1¼ inches, thins out at its edges, but is about ⅜ inch thick at its middle. It can be expressed completely and seems to have been free in the bursa. An elliptical incision of the synovia adjoining the incision is made. The synovia looks avascular and does not suggest inflammation. These two specimens are given to the

pathologist for frozen section report. He returns the report of round-cell infiltration, but no definite evidence of tuberculosis or active inflammatory disease. Accordingly the triceps bursa is completely cleaned of all its synovial lining, removing all the tags.

Further inspection of the joint revealed a few smaller masses of fibrous material similar in type to the one first expressed which were also free. The bursa had been very much distended, obviously only partially with joint fluid and principally with this fibrous mass. Others were seen hanging from the surface of the synovial lining, and a mass of this material solidly filled up the olecranon fossa where it was adherent and where it had obviously provided mechanical limitation to extension.

X-rays had, show an area suggesting necrosis in the posterior mesial corner of the ulna and it is felt inadvisable to leave this uninvestigated. The capsule is accordingly cut away from near the base of the olecranon and back of the ulna, and stripped off

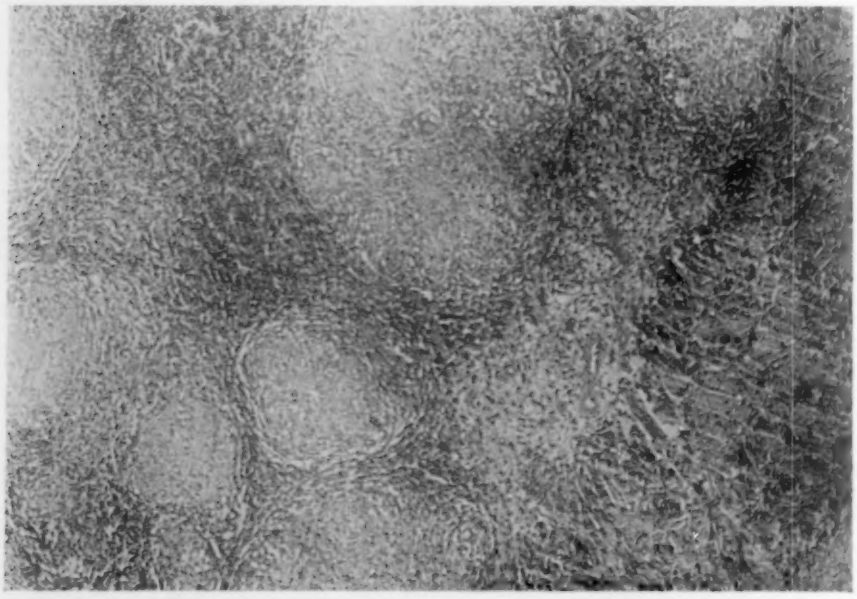

FIG. 8.—Case V. Low power of a section of synovia showing conglomerate tubercles, practically no normal tissue being seen.

enough from the joint line to expose the cortex of the ulna over this area. The cortex is drilled with a knife revealing apparently normal, if somewhat atrophic, cancellous bone. A small curette is placed through this opening, cautiously exploring without locating anything suggesting caseation of pus."

The operator's impression of chronic hypertrophic or villous synovitis with tendency toward that pathology styled osteochondromatosis by Henderson seemed to be sustained by the frozen section report. Accordingly it was with greatest surprise that the report of the fixed sections was received a few days later. The report follows:

"Sections show the synovia infiltrated throughout by round and wandering cells. In places there are typical whirls of epithelioid cells with giant cells scattered throughout or at the centre, forming typical tubercles. In other areas we see larger collections of epithelioid cells with areas of homogeneous blue-staining material at the centre."

Although the incision healed per primam without local inflammatory signs, the temperature was up to 102° for the first two days, being normal on the fourth day. The elbow was extremely sensitive and following final pathological report policy of early movement was changed to immobilization, kept up for two months, and very gradual motion encouraged. At this time the elbow showed no swelling or tenderness, and had

developed a range of 45°, but checked at this point by pain. Patient was not willing to follow advice on continuing the limited motion brace and dropped out from observation. We obtained a report six months post-operative from another röntgenologist who reported still no evidence of bony pathology.

Case V.—R. E., Case No. 87,584, a Scotch housewife of fifty-two, registered in the Clinic on January 8, 1927,¶ complaining of lameness and disability in the right knee of two years' duration. The onset had been moderately rapid but without any injury recalled. First symptom moderate pain on use, followed by increasing lameness and swelling. After a few months marked swelling developed with pain becoming constant and preventing any movement. Knee was lanced with discharge of thin yellowish fluid lasting for one month only. Condition improved following this and she could resume most of her household duties with an incomplete range of motion. Occasional exacerbations responded to rest till six months previous when swelling rapidly recurred with complete restriction of motion from pain. Knee was lanced again and drained for six weeks. Subjectively there was improvement and she could be around on the leg but with joint motion about half normal. This was painful, however, had become progressively more so till now she could permit no movement at all.

There was a past history of a tuberculous finger removed at age of four. Although always spare and never weighing over 100 pounds, had led an active life and borne nine children; in the last few years she had weighed about 75 pounds, present weight being 70.

Physical examination: A rather anæmic looking and distinctly frail but otherwise well-preserved woman in no obvious discomfort. The right leg was maintained with knee extended. There was marked atrophy of thigh and calf but actual enlargement of knee was slight. There was definite fulness below and around the patella. There was no redness but slight local heat. Periarticular tissues were definitely thickened but there was no fluid wave. While tenderness to pressure was slight, only a few degrees of movement of the joint could be obtained on account of pain and muscle spasm. There was a small healed scar at the outer side of the patella.

General examination revealed unimportant findings save for evidence of old fibroid phthisis in the right upper chest and moderate myocardial weakness (EKG) with an indefinite systolic murmur and presystolic thrill. Blood-pressure was 90/56.

Blood Wassermann test was negative and urinalysis showed normal findings. White blood count was normal and reds four million. Temperature and pulse rate normal.

X-ray films of chest confirmed, clinical impression with additional evidence of some infiltration in the other apex. X-rays of knee showed some general osteoporosis and rather marked increased radiability of the cortical portions of the articular areas, but no loss of joint space or definite evidence of erosion of joint surface and no point in either bone suggestive of focal necrosis.

Supported by recent previous experiences, the original clinical diagnosis was tuberculous synovitis, operation advised and patient admitted to hospital for this. The next day she became very hoarse with a definite laryngitis and temperature over 100. A period of observation was decided upon and plaster fixation was applied to the knee. At the end of a week temperature had become normal and voice had largely returned. In this period the Nose and Throat Division had done a direct laryngoscopy with impression of early laryngeal tuberculosis. A course of ephederin treatment had raised blood-pressure to a systolic average around 110. The knee had become entirely comfortable at the end of the second week. Operation was performed under spinal anæsthesia, including a biopsy of synovial tissue followed by routine arthrodesis. That part of the operative note describing the pathology is quoted herewith:

Pathology: "The knee when exposed shows cartilaginous surfaces everywhere normal looking and intact save for one point about one mm. in diameter at the front of

¶ This last case has been added to the series reported before the Clinic Orthopædic Society in November, 1926.

the lateral condyle, where there is a small defect with a fresh red bony surface beneath and it quite definitely suggests an accidental injury during the biopsy. The synovial membrane is hypertrophied throughout and at the sides of the joint sac, in the posterior compartment, and in the notch there is a distinctly pathological looking membrane and granulation tissue. No granulation tissue encroaches on, or has affected the cartilaginous surface. Bone sections reveal no osseous pathology."

Pathological report: "The specimen consists of right knee. The joint parts of femur and tibia are cut in thin slices. The cartilaginous joint surfaces are smooth and pale. The synovial fringes are thickened by fatty and fibrous changes and their surfaces show everywhere granular and nodular whitish gray deposits. On cut the bony parts are rather fatty and cancellous. The thickened synovia cuts like scar tissue and shows fibrosis.

Microscopic: Section A shows the tissue removed to be infiltrated throughout by round and wandering cells and whirls of epithelioid cells often with giant-cells at the centre. The latter form typical tubercles.

Section B through this tissue shows the same almost replaced by whirls of epithelioid cells which in many cases show giant-cells at the centre, thus forming typical tubercles, single and conglomerate. In addition to the tubercles there is intense round and wandering cell infiltration throughout the tissue.

Diagnosis: Tuberculosis (synovial)."

Post-operative convalescence was ideal, entirely unaccompanied by any shock, and although temperature was elevated again for the first week, no pain was complained of after the second day. Wound healed kindly and general condition seemed excellent. Patient was discharged in cast at the end of two weeks, and subsequently was given a leather knee case, which she is still wearing.

SUMMARY

Five patients suffering from a chronic joint disorder of from two to seven years' duration presented physical findings inconsistent with those commonly looked for in established joint tuberculosis, and X-ray films negative for bone destruction or absorption. All came to radical operation widely exposing the joint and revealing the pathology of long-standing tuberculosis throughout the synovial membrane unaccompanied by any lesion of bone. Four were adults between ages of twenty-three and thirty-one in excellent general health and free from constitutional stigmata of tuberculosis. In none did a pre-operative diagnosis of joint tuberculosis seem to have clinical support.§

CONCLUSIONS

Chronic slowly progressing tuberculous arthritis of exclusively synovial pathology, though not usual, is a definite clinical entity to be kept in mind in differential diagnosis. In chronic monoarticular joint disease biopsy of synovial membrane may frequently be necessary for diagnosis.

§ Since submission of this paper two patients have come to exploratory and subsequently radical operation, in whom a joint disturbance of from twelve to fifteen months had been present, X-ray examination was negative for bony involvement, joint surfaces were completely preserved in integrity and extensive tuberculous involvement of the synovial membrane was present.

THE PATHOGENESIS AND TREATMENT OF ACUTE EPIPHYSITIS

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A form of acute osteomyelitis occurs in which the focus of infection centres in an epiphysis. Necessarily this is found to occur while the epiphyseal cartilage still exists; and, most frequently, it affects children and infants. Commonly this is called acute epiphysitis. Acute epiphysitis occurs very frequently; its essential nature is often hidden in the gross lesion, and in complicating factors; it has a large morbidity and a high mortality; and, in those who recover, wrong principles in treatment frequently are followed by disabilities of various kinds which form great handicaps to the function of the joint and of the limb. The purpose of this communication is an explanation of the essential mechanism of acute epiphysitis; of the pathogenesis whereby the full development of such foci of infection are accomplished; of the clinical manifestations which accompany these changes; of the ways in which complications especially joint complications develop and the character and form of the latter; of the effects the latter have in changing the dominant characteristics of the clinical picture; and of the principles according to which treatment should be undertaken.

The present discussion includes only those cases of acute epiphysitis caused by the ordinary forms of pyogenic bacteria. Cases due to infection by tubercle bacilli, syphilitic virus, or actinomyces are not included; nor any case originating in such obscure pathology as that associated with thromboangeitis obliterans, the various forms of vascular gangrene, Volkmann's contracture, etc.; nor those cases customarily described under the terms, osteochondritis deformans jevenalis coxæ (Legg's disease—Perthes' disease), Osgood-Schlatter's disease, Kohler's disease, etc.

The etiological causes of acute epiphysitis are no different than those which are found in the ordinary cases of acute osteomyelitis in which the lesion is centred in the diaphysis of the bone; they include infection by staphylococci, streptococci, etc. Although some of the text-books speak of cases of acute epiphysitis which follow the infectious diseases such as typhus and typhoid fevers, etc. I have personally never seen such a sequence of events and from a consideration of all of the available facts I am convinced that acute epiphysitis following such infections is caused by similar bacteria, is of extreme rarity, and is possibly a coincidence.

Exactly as in cases of acute osteomyelitis cases of acute epiphysitis find their origins in and form lesions—fixation points—of states of bacteriæmia

or general blood infection.* The mechanisms whereby these general states of infection find their inceptions and develop subsequently, were extensively discussed in previous communications and will only be summarized here as follows:

States of bacteriæmia and general blood infection are derived from foci of infection which develop on a surface of the body—external skin, mucous membranes lining the alimentary, genito-urinary, pulmonary, etc., tracts, etc. The exact mechanism of their production is found in the presence of a thrombo-phlebitis in which bacteria are present and in which the continued growth of the latter results in a penetration of the substance of the clot until

* The old terminology used in association with the phenomena of bacterial infection and including such terms as sepsis, septicæmia, sepræmia, pyæmia, etc., will not be employed in this communication. The reasons for this were described in a previous communication and a simplified terminology was suggested. In accordance with the latter only the following terms—infection, bacteriæmia and general blood infection will be employed in this communication with the following definitions:

1. The term "infection" will be used as a generic one and will include all of the phenomena of a bacterial attack on tissue, organ or the entire body. The various kinds of infection will naturally be described in accordance with the tissue, organ, or part of the body involved, and in accordance with the organism, or organisms encountered; thus saprophytic infection of the uterus, staphylococcus infection of the skin or streptococcic infection of the liver, etc. When no other modifying term is employed it is to be assumed that cultivations of the peripheral blood taken during life are sterile. The differentiation commonly made between local and general infection theoretically does not exist and the terminology is one more of convenience than of accuracy. Local infections must necessarily involve some degree of general constitutional reaction and general infections must necessarily find their beginnings in, or be associated with a local focus of infection. As far as possible this differentiation will be avoided or made clear in the text whenever it must be used.

2. The term "bacteriæmia" will, also, be used in a generic sense to indicate any condition in which living bacteria can be cultivated from the peripheral blood during life. The various kinds of bacteriæmia will, also, naturally be described in accordance with the organism found: thus, staphylococcus bacteriæmia, streptococcus bacteriæmia, etc.

3. The term "general blood infection" will indicate a subgroup of the generic term "bacteriæmia" and a distinction will be made between the terms "bacteriæmia" and "general blood infection" on the following basis: The term bacteriæmia is meant to imply a condition in which the organisms demonstrable in the circulating blood by the usual cultural methods are derived from a local lesion somewhere in the body, are usually small in number and the faculty of destroying the circulating bacteria is more or less retained by the appropriate antibodies of the blood. The term "general blood infection" is meant to imply a condition in which in addition to the foregoing a multiplication of the bacteria takes place in the circulation and the faculty of destroying the circulating bacteria is more or less lost by the appropriate antibodies of the blood.

Under appropriate circumstances both of these groups of terms will be employed together: Thus staphylococcus infection of the skin with staphylococcus bateriæmia or general blood infection. The character of the local lesion in the complete development of any individual infection is best described by the use of the terms "primary," or "secondary" ("metastatic," "subsidiary"): thus, "primary streptococcus infection of the tonsil with secondary streptococcus infection of the appendix," etc., the absence of any descriptive bacteriæmia indicating that a cultivation of the peripheral blood made during the course of the illness was sterile.

the organisms reach the surface of the thrombus in direct contact with the circulating blood: the bacteria demonstrable in the cultivations of the peripheral blood are these same organisms which are carried away from the surface of the clot either as isolated organisms or as clumps of organisms by the force of the circulating blood. Pieces of infected blood clot also become broken away and dislodged from the mother clot and the free fragments when arrested in the capillary circulation of some nearby or distant tissue or structure of the body form "fixation points" around which secondary, subsidiary or metastatic foci of infection are developed. Such subsidiary foci develop in bones, joints, the intramuscular facial planes, the viscera, etc.

Environmental factors and conditions determine in a similar way the localization of a focus of osteomyelitis and of acute epiphysitis, one of its varieties. In actual disease the contributory local factors which determine the fixation point of a focus of infection under the clinical manifestations of an acute epiphysitis must necessarily exist in the epiphysis itself and in its vascular structure. As in acute osteomyelitis the two important local factors are (1) the exhibition of some form of trauma—physical and mechanical trauma, chemical trauma, etc.; and (2) the anatomical characteristics of the local circulatory network and the physics of the local blood circulation at the given moment. Each of these two factors are of equal importance in the localization of a fixation point in the immediate environment of an epiphysis.

Cases in which the trauma preceding the manifestations of an acute epiphysitis is a distinct physical entity are of common experience and are met in almost daily practice. The degree of the trauma and its extent varies all the way down to minor grades until it is so slight as to be unrecognizable. The resulting physical basis for the development of a subsidiary focus of infection is a gross or microscopic hæmatoma associated with blocking of the circulation at one or more points because of gross or microscopic tearing of vessels; at the point where the continuity of the circulation is thus broken, the arresting of blood and bacterial emboli becomes likely; this is the point of fixation in and around which a focus of infection develops.

Other forms of trauma occur; these have been fully discussed on previous occasions. The discussion will not be repeated here because of the relative unimportance of other forms of trauma when compared with physical trauma.

Under any circumstance a fixation point is formed by the arresting of a thrombus-embolus at some point of the vascular network. The actual point frequently depends more upon chance than upon anything else and is decided by the physics of the local epiphyseal circulation at the given moment in accordance with the facts previously outlined. Infection comes about because of the presence of living bacteria in the arrested thrombus-embolus, or by the attraction of organisms carried to it in the free circulation. Various pathological pictures result depending upon the size of the plugged vessel, the relative position of the plug in the vascular network, the powers of vascular anastomosis, etc., in conjunction with the character, type, virulence, etc., of the organisms giving rise to the infection.

A typical specimen of the circulation in a long bone is shown in Fig. 1. There is a separate circulation for the diaphysis and for the epiphysis. The circulation of the epiphysis enters most often at more than one point, among which oftentimes a main channel can be distinguished. The epiphyses obtain their blood supply from the periosteal network of arteries, large branches of which perforate the thin layer of compact tissue on their exterior, and are distributed throughout the spongy cancellous tissue.† Practically the whole of the blood supply of the epiphysis is therefore independent of that of the diaphysis. Only one or two minute vessels pass into the epiphysis from the diaphysis through the conjugal cartilage. This accounts for the comparatively infrequent occurrence of necrosis of the epiphysis in traumatic separation of the epiphysis even when the latter is more or less completely displaced from off the diaphysis. The circulation of the diaphysis is derived from a large vessel, the nutrient artery of the bone which enters a little to one side of the centre of the shaft. Immediately, the main vessel divides into a number of large branches which pass, some of them upward and some of them downward toward either end of the shaft. A diffuse network (Figs. 1 and 2) is formed which supplies the entire interior of the bone and its medullary cavity. Toward the end some of the main branches become end vessels. There is a free anastomosis between the plexus of vessels thus established and the vessels derived from the periosteum through Sharpey's fibres. In a growing bone, with the epiphyseal cartilage still present, there is little direct anastomosis between epiphysis and diaphysis and a relative avascular area results; in a fully grown bone there is an extensive anastomosis between the two.

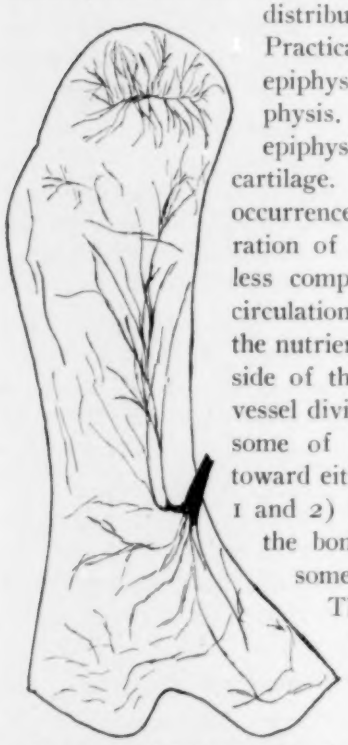

FIG. 1.—Typical blood supply of any long bone. Taken from E. Lexer, Kuliga and Turck. Note the diaphyseal and epiphyseal circulations and the relative avascular area between. Note the attempt at the formation of a main channel in the epiphyses. This and the following are injection specimens.

The avascular area in a growing bone results from the termination of the epiphyseal and diaphyseal circulations within a short distance of the epiphyseal line. The terminal vascular network on either side is made up of vascular loops which result from the free and extensive anastomosis, (1) on the epiphyseal side, of the various vessels and their branchings which supply the bone structure of the epiphysis, and (2) on the diaphyseal side, of the free and extensive anastomosis of the numerous terminal branchings of the nutrient artery of the diaphysis of the bone near the avascular area; on the diaphyseal

† In the hip-joint the blood supply of the epiphysis which forms the head of the femur is derived from a single vessel which passes to it in the ligamentum teres: the vessel is the terminal part of the transverse branch of the internal circumflex artery, a derivative of the deep profunda branch of the femoral artery. (Vide Fig. 2.)

side of the conjugate cartilage end vessels are also present. Nutrition in the avascular area is a lymphatic affair.

This is the physical anatomical structure and the functional physiological basis upon which the local lesion of an acute epiphysitis is built. For obvious reasons the essential nature of the pathological lesion in acute epiphysitis is the exact counterpart of that of acute osteomyelitis in the diaphysis of a bone and any slight peculiarities are due to differences in arrangement of the vascular tree in the epiphysis as opposed to that in the diaphysis. The dominant characteristics of the pathological picture are (1) a thrombo-arteritis or thrombo-phlebitis, and (2) a necrosis of bone and cartilage cells consequent to the disturbances of circulation produced by the plugging of the vessels. The physical characteristics of the pathological picture depend to the largest extent upon the second factor. The fact that a number of independent vessels furnish the blood supply leads to the circumstance that in epiphysitis the amount of bone in the epiphysis which necroses must necessarily correspond accurately with the extent of territory controlled by the plugged vessel as modified by the capabilities for collateral circulation from other arterial radicals which enter the substance of the epiphysis. In actual practice all grades of destruction can be seen. The maximum necrosis which results from a thrombo-phlebitic process in an epiphysis is seen most classically in the hip-joint where the characteristics of the blood supply of the head of the bone—a single nutrient artery passing in the ligamentum teres—lends itself peculiarly to total destruction of the head of the bone. Essentially there is an exact reproduction of all varieties seen in the diaphysis of a long bone—from minimum branch lesion to maximum nutrient artery trunk lesion—as previously described (ANNALS OF SURGERY, November, 1925).

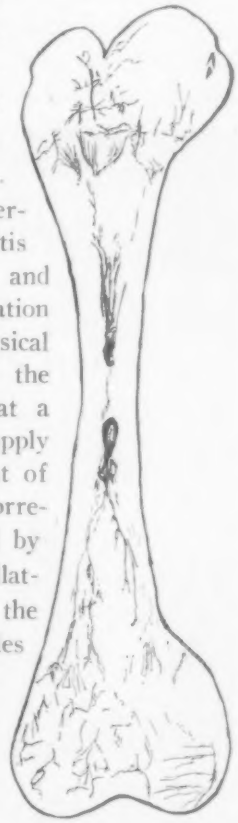

FIG. 2.—Circulation of the femur as shown by E. Lexer, Kuliga and Turck. Note the general similarity to the circulation in Fig. 1. Note that there is a single vessel which is perforating the head of the bone and that this is practically the entire blood supply for the head. Compare with Fig. 4. in which the results of a thrombo-embolic process in the vessel is shown and how closely the amount of bone destruction corresponds with the territory supplied by this vessel.

Cases are seen rarely in which the radiographic evidences of the final extent of the lesion show simultaneous involvement of both epiphysis and diaphysis either in whole or in part, (1) either grouped apart from one another and separated by appreciable intervals of healthy tissue or (2) grouped together at one end of a bone. The physical basis of these atypical lesions in (1) exist in the occurrence of more than one independent fixation point within the confines of a single bone; and in (2) in the occurrence of (a) a single thrombo-embolic lesion in a larger vessel, the branches of

which supply both epiphysis and diaphysis where they lie in relation to one another, or (b) of independent fixation points in vessels supplying the epiphysis and diaphysis where they lie in relation to one another with primary overlapping of territory supplied with blood or with secondary fusion of the independent thrombo-phlebitic processes. Commonly, however, such combined lesions are the results of operation.

Clinically it is found that cases of acute epiphysitis, like cases of acute osteomyelitis in general, can be grouped into three varieties:

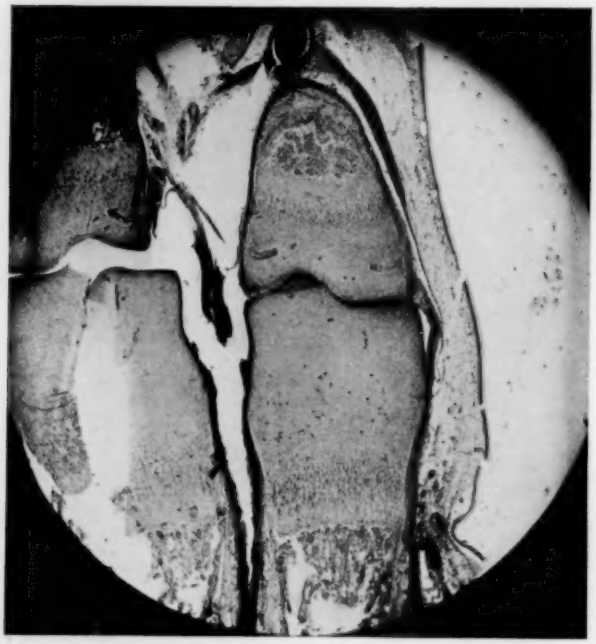

FIG. 3.—Longitudinal section through the bone of a fœtal pig. Note the epiphysis, the conjugate cartilage and the diaphysis of which approximately half is shown. Note the centres of ossification in the epiphysis and in the diaphysis. The vascular areas surround these centres. On the epiphyseal side of the conjugate cartilage two vessels can be seen perforating the epiphysis from either side; these are derived from the periosteal circulation. Note the large avascular area on the diaphyseal side of the conjugate cartilage.

(1) In the first variety a focus is present in one of the epiphyses with well-marked local signs and symptoms but without any clinical signs of a general blood infection. A bacteriæmia is not present. The physical basis for this variety lies (a) in a primary and temporary bacteriæmia; (b) in the development of a fixation point in the given epiphysis, and (c) the subsequent spontaneous disappearance of the bacteriæmia.

(2) In the second variety a well-marked focus is present in one of the epiphyses with abundant local signs and symptoms and, in addition, there are clinical indications of a bacteriæmia as evidenced by the general signs and symptoms and by the demonstration of living bacteria in the blood stream. The physical basis for this variety is the presence of an infected thrombus-embolus formation which serves to keep up a demonstrable bacteriæmia by constantly feeding into the blood stream a comparatively small number of viable organisms. Most commonly, either after or without efficient surgical treatment, the bacteriæmia eventually disappear and a recovery is made. It must be remembered that any of these cases may at times pass into the third group.

(3) The clinical picture of the cases in this group is that of a profound general infection: there is a marked toxæmia. A local focus is either not demonstrable at all because of the paucity of local signs and symptoms, or

because the latter are hidden in the profound intoxication; or, if present, the local lesion is easily recognized as being of no consequence in the total clinical picture. The physical basis for the clinical picture lies in an extreme and severe general blood infection with highly virulent organisms in which the bacteria are rapidly multiplying in the blood stream and because of which the subject is rapidly being overwhelmed by a tremendous intoxication. The presence of the infected thrombus-embolus formation forms a negligible factor and the few organisms that are derived from this source play only a primary and inciting part in the production of the bacteriæmia; the subsequent multiplication in the blood stream depends on other factors, the most important of which is the poor resistance of the subject. An endocarditis is usually found under these conditions. In this variety the local point of fixation plays no rôle in the production of any part of the clinical picture. Usually the pathological anatomical picture is not in a very advanced stage at the time the lesion is exposed, either on the operating table, or, as more commonly happens, in the autopsy room.

In actual disease it seems certain that the cases differentiated in these groups form progressive stages each from the next preceding group. A case in group 1 may pass into group 2; and, conversely, a case in group 2, having been appropriately treated, may retrogress into group 1 as it proceeds to healing and recovery. These interchanges are constantly occurring in clinical surgery. A case in group 2 may pass into group 3 as is previously noted; usually under such conditions there is a continued progression until the eventual fatality. In actual practice cases in group 3 must necessarily first pass through the stages indicated by groups 1 and 2; the time interval may be so short, however, owing to the virulence of the infecting organism, or the relative non-resistance of the subject, as to make these stages unrecognizable. One can explain the cases that apparently begin with the characteristics of the cases in group 3 in this way. In many cases characteristics can be distinguished which belong to both group 2 and group 3; and insofar as any case partakes of characteristics not belonging to its group, it differs in its clinical manifestations. I have never seen a case in group 3 retrogress spontaneously into group 2; it seems almost impossible to believe that such retrogression can ever occur.

The most important local complication of acute epiphysitis is joint infection. It is a matter of great difficulty, clinically, to make correct judgments as to the coincidence or absence of an epiphysitis with an acute joint infection, as to the relative dominance of the one over the other part in the total clinical picture and as to the relation of either of them to an accompanying bacteriæmia. This is an especially great difficulty in the most severe cases of group 3, even though in these cases a fatality is always to be expected, and the differentiation would then be of no practical value. Clinically, a number of possibilities are present depending on the relation of the epiphysis to the interior of the joint capsule and to the reflection of the synovial membrane. Anatomically, the various epiphyses have variable relations to their corre-

sponding joint interiors depending on the physical structure of the individual joint; in some of the joints the epiphysis lies altogether outside of the joint; in others it lies outside of the joint only partially; in still others it lies altogether within the joint. The observable clinical possibilities are as follows:

A. An epiphysitis develops with or without abscess formation and during the entire course of the infection, there is no demonstrable evidence pointing to involvement of the joint. The physical basis for this naturally lies in the location of the fixation point in an epiphysis or in that part of an epiphysis which is entirely outside of the joint.

B. An epiphysitis develops with or without abscess formation and the clinical signs of joint involvement come only later. If this should appear before any operative incision, it indicates that the fixation point was originally situated in a part of an epiphysis which was outside the joint capsule and that joint involvement took place because of one of two factors: (1) either the death of tissue in the epiphysis consequent to the interference with the circulation resulted in sequestration which mechanically opened a pathway into the joint cavity; or (2) because of the spread of the infective process. The physical basis for the latter is the extension of the thrombo-phlebitic process ‡ along the vascular channels; and the most important, if not sole cause for the extension lies in the continued growth of living bacteria within the substance, and on the surface of the thrombo-phlebitic clot.

If the signs of joint involvement come after operation the possibilities are: (1) that the complication occurred from a mechanical opening into the joint and that the latter occurred during the operative manipulations either accidentally or perhaps, purposefully; or (2) the unavoidable cutting and traumatism of many vascular channels in the field of operation aided and abetted the spreading of the thrombo-phlebitic lesion.

I have the impression that, especially in acute epiphysitis, spreading of the thrombo-phlebitic lesion does not commonly occur in the absence of any outside interference. Joint complication is almost always due to a primary involvement of a part of an epiphysis which is within the interior of a joint. I have the further impression that most of the time spreading of the lesion appears pari passu with unwise operative manipulations. The more I see of these cases the more I am convinced that in the largest proportion of the cases—and this proportion seems to be constantly larger in my experience—the final extent of the undisturbed lesion corresponds to the extent of

‡ The subject of vascular thrombosis is an extremely important one in explaining the mechanism and pathogenesis of bacterial infection in bone tissue. It has been adequately discussed on a previous occasion (*Arch. Surg.*, 1926, vol. xiii, p. 228 and ANNALS OF SURGERY, November, 1925) and the discussion will not be repeated here. Suffice to say that the spread of vascular clotting under the influence of (1) the original embolus-thrombus formation or (2) of persisting infection in the clotted area is the most important single factor (1′) in explaining certain primary characteristics of acute osteomyelitis, (2′) in enabling a proper classification of the various types of individual lesions, (3′) in explaining certain hitherto obscure phenomena of the disease, and (4′) in properly presenting a sufficient mechanism for the apparent or actual spread of the primary lesion.

territory deprived of its nutrition by the thrombo-phlebitic process; that, ordinarily, no increase of the extent of tissue involved occurs later; and that the total final extent of tissue involved is, for practical purposes, an accomplished fact at the very moment when a fixation point is firmly established at any given point of the vascular network of a bone either in the diaphysis or epiphysis.

C. An acute joint infection develops and at operation it is possible to demonstrate a focus of infection in an epiphysis in the interior of the joint. It is immaterial whether the given epiphysis lies wholly or partially within the joint; the focus of infection is in that part of it which lies within the joint.

With these fundamental facts in mind it becomes apparent that in the treatment of acute epiphysitis, exactly as in acute osteomyelitis in general, one has a two-fold object to accomplish: (1) the treatment of the general infection (bacteriæmia—general blood infection); and (2) the treatment of the local lesion.

TREATMENT OF THE GENERAL INFECTION (BACTERIÆMIA)

In any case a relative quantitative estimation of the magnitude of the infection can be established according to the number of colonies of bacteria which appear in the plate culture method in proportion to the amount of blood used to inoculate the culture medium—thus 1 or 5 colonies of bacteria per one cubic centimetre of blood as compared with 100, or an uncountable number of colonies of bacteria per one cubic centimetre of blood. This is a very rough method and is not strictly accurate, but for practical purposes the inaccuracy is inconsequential.

In practice the presence or absence of a bacteriæmia or general blood infection yields the following clinical groupings and the correct interpretation of the bacteriæmia in its relation to the clinical manifestations yield certain therapeutic indications.

A. Treatment of the general infection is many times not called for, as commonly the clinical manifestations of the general infection are mild and the natural protective agencies of the body are able to nullify the bacteriæmia and its effects. Many times, unless one understands the essential nature of the pathological process involved in the development of a focus of infection in an epiphysis, the question of the bacteriæmia does not enter into therapeutic consideration; this is so because, as pointed out on previous occasions, the initial bacteriæmia was a temporary phenomenon and sufficient time had elapsed between its appearance and the moment of observation to allow for its spontaneous disappearance. Under these circumstances there are no clinical or laboratory evidences of its existence. Good prognoses should be the rule under these circumstances.

B. At the opposite end of the picture are those fulminating, progressive and severe forms of bacteriæmia and general blood infection, the existence of which is associated clinically with a symptom complex in which the local focus of epiphysitis is of minor and secondary consideration and in which the

manifestation of the bacteriæmia or general blood infection is the dominating factor in the entire clinical picture. Large numbers of viable organisms are demonstrable in the blood cultivations in such severe cases. The local focus may exhibit definite signs of its presence, or may be unrecognizable and undemonstrable owing either to the paucity of its clinical manifestations or to the profound intoxication produced by the general blood infection.

Any kind of local condition may be associated with such a general blood infection. It is to be assumed under such conditions that large numbers of viable organisms are being discharged into the blood stream from the thrombo-phlebitic area and that the bacteria are probably multiplying in the blood also. The prognosis must therefore be a very serious one. The usual course of affairs includes a steady progression of the general blood infection until a fatality occurs. Under these circumstances treatment directed to the local lesion is futile and fatalities are the rule and not the exception. One must understand that here one is dealing primarily with cases of general blood infection and any treatment which is possible and permissible must be directed to the general infection; the local lesion plays a minor rôle. The promise that operation on the focus in the epiphysis "furnishes the unfortunate patient his only chance" is sometimes something which may not be refused in the presence of anxious parents, relatives or friends; but whenever such earnest desires are acceded to, it should be unequivocably emphasized that the "chances" are practically nil. In the fulminating cases the entire duration of the illness is most often a question of a few days.

FIG. 4.—The result of an acute epiphysitis in the upper epiphysis (head of the femur) of a young child. Note the amount of bone which has disappeared from the head as a result of the focus of infection and note how closely this corresponds to the territory as shown in Fig. 2 which is supplied by the artery which enters the head through the round ligment.

There are other somewhat less severe forms of acute osteomyelitis in which the blood contains large numbers of viable organisms, but in which the clinical picture does not carry with it that comparatively sudden overwhelming of the body with a profound toxæmia. Following operation there is little

or no lessening in the magnitude of the bacteriæmia or, possibly, an increase in the latter. Under these circumstances the question of amputation should be discussed when the local conditions lend themselves thereto.

C. In between the mild cases of group 1 and the very severe cases of group 2 there exist large numbers of cases of acute osteomyelitis in which (1) there are well-marked evidences of one or more foci of acute osteomyelitis and (2) a demonstrable bacteriæmia.

Blood cultures obtained under these circumstances can be employed (a) in appropriate cases as an additional means of differential diagnosis; (b) as means by which the severity of the infection can be gauged; (c) as a help in estimating the prognosis; (d) as criteria upon which to base the primary or further operative treatment.

Occasionally the character of the organism demonstrated in the blood culture can be employed as a differential point in diagnosis. Cases are constantly being seen in which it is difficult to decide whether the localization has occurred in a bone or in a neighboring joint. True enough this sometimes indicates a simultaneous or successive involvement of both, but in other cases the localization is hidden in a general inflammatory reaction. Under these circumstances the demonstration of organisms of the staphylococcus group—staphylococcus aureus especially—indicates that the chances are greatly in favor of a primary involvement of bone tissue; the demonstration of organisms of the streptococcus group would speak in favor of a primary synovial involvement. The differentiation carries with it a possible therapeutic indication. Other things being equal, the demonstration of organisms of the staphylococcus group with its consequent interpretation of a bone lesion would ordinarily favor exploration of the bone in cases of doubt; while the demonstration of organisms of the streptococcus group would carry with it a more conservative attitude at least as far as exploration of the bone were concerned.

In cases of acute epiphysitis the relative magnitude of the bacteriæmia or general blood infection is capable of yielding information valuable for a correct gauging of the prognosis. This information can be classified as follows:

A. In cases of acute epiphysitis blood cultures showing approximately one to five colonies of organisms to the cubic centimetre of blood are usually, but not always, of a mild nature, frequently show little or no evidence of their existence, are associated with symptom complexes which do not differ materially from similar cases of acute epiphysitis in which the blood cultivations are sterile, and frequently disappear spontaneously or following operation. Good prognoses are the rule in these minor bacteriæmias.

B. On the other hand, blood cultures can be obtained in which the numbers of colonies are extremely large—100 or more colonies to the cubic centimetre of blood. Always this indicates a severe infection and an extremely grave prognosis. The clinical picture commonly shows an equal evidence of the severity of the infection. The interpretation of such blood cultures has been referred to already in considering the fulminant cases of acute osteo-

myelitis. There will be many cases in this group in which one will have no doubt as to the need for operation upon the local focus of epiphysitis and one will proceed confidently on these. There will be many other cases in this group in which one will be somewhat in doubt as to the correct interpretation of the relationship of the clinical picture to the bacteriæmia or general blood infection, especially in those cases bordering upon the fulminant cases referred to previously. Under such circumstances one must operate upon the local demonstrable focus of osteomyelitis and remove it radically when the local conditions lend themselves thereto.

C. In between these two extremes are large numbers of cases in which the blood cultivations show an intermediate number of colonies of bacteria. When a given blood culture is compared with subsequent ones taken on the same patient the lessening of the number of colonies, or their disappearance, undoubtedly bespeak an improvement *when other conditions are equal.* An increase in the number of colonies should always be cause for alarm and for a prompt reconsideration of the available clinical picture and revision of all the demonstrable foci whether they are in the bone or in complicating and associated foci in other tissues. Comparisons made along these lines are of extreme usefulness and importance in bedside and operating room work.

D. In the presence of a positive blood culture a prognosis of the ultimate outcome in cases of acute epiphysitis should not be attempted except after consideration of all the available clinical facts. While a positive blood culture is always a serious thing, especially from the point of view of the possibilities which may occur, it is usually found that the seriousness of the latter is paralleled by the characteristics of the clinical picture. The prognosis should always be guarded. Much depends upon the availableness of the local focus of infection for thorough surgical removal and upon the performance of the latter procedure before other uncontrollable complicating foci have appeared.

Negative (sterile) blood cultures, obtained either primarily or secondarily in cases of acute epiphysitis, should not always be associated in one's mind with the milder type of case or with improvement. Quite the contrary can be the case and negative blood cultures can be obtained in the presence of the most profound infections. The available clinical and laboratory data indicate that the demonstration of a sterile blood culture may be an accident and occur in the intervals between repeated temporary states of bacteriæmia and be associated with an autosterilization process which takes place in the blood or in certain important organs, especially the liver; the occurrence of complicating and secondary foci, other than the bone focus and subsequently to it, in the presence of negative blood cultures, is the most powerful proof of these temporary bacteriæmias.

In the presence of positive and negative blood cultures a progressive impoverishment of the general condition of the patient is frequently due to the magnitude and number of the various fixation points that have occurred or to their location in important viscera or localities of the body rather than to the presence of the blood infection and of its consequent toxæmia. Posi-

tive blood cultures are sometimes only obtainable at a late stage of the illness. Death results either from a general progression of the entire infection or from the results of any one particular manifestation—as, for instance, from the results of a localization in the lungs and pleura.

The actual treatment of the bacteriæmia or general blood infection is the surgical removal of the focus of infection containing the thrombo-arteritis or thrombo-phlebitis from which the bacteriæmia or general blood infection is derived. In any given case the presence of the bacteriæmia may be referable (1) to the original primary lesion, (2) to its secondary focus in the bone, (3) to the presence of a focus subsidiary to the secondary focus (bone or other) which by itself is capable of creating a bacteriæmia, (4) to the presence of a valvular lesion (endocarditis) and (5) to the presence of some other complication capable itself of giving rise to a bacteriæmia or general blood infection.

FIG. 5.—An X-ray photograph of the final result of an acute epiphysitis of the head of the femur in a young child taken two years after the onset of the illness. The focus in the head of the femur was subsidiary to a thrombosis of the lateral sinus which complicated an otitic infection. The hip was treated conservatively and operation of any kind was not found necessary. There was complete recovery. The funtional end result compares very favorably with that of the case, the X-ray of which is shown in Fig. 4.

Except in cases of acute epiphysitis which follow specific infections as pneumococcus pneumonia, etc., or which follow certain definite conditions as an acute mastoiditis with thrombosis of the latent sinus, and which make their appearance during the course of the primary illness, the primary lesion to which the focus of infection in the epiphysis is secondary, is not ordinarily recognizable or demonstrable by the ordinary clinical or laboratory means. In the average case seen the question of the primary lesion does not enter.

In practice one should assume under any other circumstances than those just mentioned that the bacteriæmia is most likely derived from one or other of the foci demonstrable in the epiphyses.

THE TREATMENT OF THE LOCAL LESION

The treatment of the local lesion of an acute epiphysitis similarly to that of acute osteomyelitis should be based (1) upon a consideration of the mechanism by which the foci are produced; (2) upon the character of the lesion which is produced, as determined by the available knowledge and by röntgenographic evidence; (3) in accordance with the magnitude of the infection in association with the absence or presence of a bacteriæmia, and (4) in accordance with the presence or absence of associated or complicating lesions, especially joint complications. Multiple epiphyseal foci should be treated individually along similar lines and in accordance with the viewpoints and rules herein expressed.

A. Other things being equal, the absence of a demonstrable bacteriæmia or general blood infection indicates that a conservative attitude can be assumed in deciding the correct method of surgical treatment of the local focus of infection in the epiphysis. The immediate and late importance of this conservative attitude is so great as to make it the attitude of election whenever it can be possibly employed. The immediate and late benefits of conservative forms of treatment can be summarized as follows:

(1) The avoidance of any operative intervention in many cases of acute epiphysitis. From time to time cases of this kind are met in practice. Quite commonly these cases complicate the sinus thrombosis which follows an acute mastoiditis; and quite frequently the lesions are in one or more of the epiphyses in the neighborhood of the hip. Joint complication is almost always present and the clinical manifestations are largely due to the latter. Even in the presence of high fever—frequently protracted for considerable periods of time—and of other signs of toxæmia, conservative forms of treatment are always indicated when the blood cultures are sterile. The indications can be adequately met by traction and immobilization and the subsequent results have demonstrated that the natural forces of the body have been ample to control the focus of infection and to bring about an efficient healing. The late results as regards function have been very good; curtailment of the normal ranges of motion have been inconsequential and of minor degrees or have been reduced to a minimum.

(2) A much less severe—frequently, indeed, a minor primary operation in the cases with sterile blood cultures in which the operation should prove necessary. Under the circumstances the necessity for operation arises only because of an excessive accumulation of purulent matter and the latter collects (a) within the interior of the neighboring joint, (b) exterior to it under the periosteum, or in the fascial planes of the limb, or (c) in more than one of these locations either simultaneously or as developments the one from the other.

The only indication to meet under these circumstances is the introduction of adequate drainage. The actual methods of doing so follow general surgical principles and comprise (a) the simple opening of abscesses in the soft parts;

(b) the opening of subperiosteal abscesses; and (c) the drainage of joints. In any case free drainage should be provided.

(3) The much less chance of the spreading of the thrombo-phlebitic or thrombo-arteritic lesion with all the consequences hereinbefore outlined. This advantage, valuable beyond anything else, is guarded by the avoidance of any operative intervention and is least disturbed by the method of operative intervention indicated—the introduction of simple drainage.

(4) The conservation of important bone tissue. This is of maximum importance in any component which enters into the structure of a joint.

(5) The avoidance of secondary sequestrotomy. Owing to the structure of epiphyses the bony foci are necessarily limited in size; the resulting sequestra are small; and within the confines of a joint absorption of the latter is a phenomenon of extraordinary rapidity. Under the circumstances secondary sequestrotomy seems to be necessary very rarely.

The results of this plan of treatment for cases of acute epiphysitis have been very good. There is much less deformity. There is a greater usefulness because of a greater conservation of the normal structure and functions of the epiphyses and their related joints.

B. Other things being equal, the presence of a demonstrable bacteriæmia or general blood infection indicates a dangerous and possibly progressive lesion and bespeaks an urgency of effort which seeks to remove the guilty local focus as early and as completely as possible before irreparable damage is done by the spreading of the infection to the endocardium or other important organ or locality. All of the information classified in the previous part of this and in other papers as regards the clinical and therapeutic significance of a bacteriæmia or general blood infection accompanying any of the forms of an acute osteomyelitis come into play at this time and judgments should be based and indications met accordingly.

The important indication is to remove the local focus in the epiphysis as completely as possible. Conservatism should be replaced by radical removal of bone tissue frequently into healthy areas. The difficulty during these early stages is one of two:

1. The impossibility of being able to recognize the limits of the lesion in the epiphysis. The impossibility of determining clinically, or of demarcating accurately even upon operative exposure, the exact extent of disease in any given bone is an important characteristic of the early stages of the development of a focus of infection in osseous tissue. The physical basis for this exists in the manner and extent of intraosseous vascular clotting, of the consequent disturbance of intraosseous circulation and of the capabilities for collateral blood supply. Owing to the physical structure of the bone, changes are not visible to the unaided eye or on an X-ray photograph at these comparatively early stages of the development of the focus, *i.e.*, at the time these cases are usually operated upon. Röntgenological evidence of all of these structural changes only become recognizable (a) after the bone cells have died and after the bone matrix has begun to sequestrate, in which case

the discriminating shadows forming lines of demarcation and areas of absorption, rarefaction find their physical basis in the disappearance of lime salts; and (*2*) after new bone—involucrum—has been deposited around the sequestrated portions, in which case the discriminatory shadows are due to the deposition of new lime-bearing tissue; both of these physical conditions are the products of long-continued activity of processes of disease and of processes of healing and only become recognizable at a late stage. Röntgenological evidences of the "first appearances and of the subsequent development" of a focus of osteomyelitis in an epiphysis, are very liable to mislead one unless they are properly interpreted.

2. Epiphyses are commonly important component parts of joint structures. Under the circumstances the times and localities in which radical removal of the thrombo-phlebitic focus in the epiphysis is not technically possible are frequent. In addition the immediate proximity to important conjugal cartilages, and the wish to conserve as much as possible of the skeletal structure in order to preserve as much as possible of the normal growth and functions, makes undesirable any radical removal of the focus of infection in an epiphysis. In actual practice these two criteria frequently disturb and prevent ideal methods of treatment of the local epiphyseal lesion in the presence of a bacteriæmia. As much as possible should, however, be done in the way of removing the entire focus; ample drainage should be secured in addition as the next best thing; and a good deal must be entrusted to nature's efforts in spontaneously dissipating the bacteriæmia. In actual practice this incomplete method of treatment works out fairly well in the milder type of bacteriæmia; spontaneous regression and disappearance of the bacteriæmia frequently takes place and the disease continues as if no bacteriæmia had existed. In the severe type of general blood infection, one is frequently compelled to disregard anatomical structure and subsequent disturbance of function and to proceed ruthlessly to remove the entire focus of infection; the question of amputation frequently comes up; success does not always follow. In the most severe type of infection—as indicated in a previous part of this discussion—it should be recognized that operation is futile.

The clinical possibilities which follow operation and the therapeutic indications which are available are the following:

A. In many of the cases a single focus of epiphysitis only is demonstrable and a comparatively small number of bacteria is demonstrable in the blood circulation (plate culture method). If following an adequate operation in which the demonstrable focus is removed, the blood becomes sterile, the pre-operative assumption that the bacteriæmia had resulted from that particular focus becomes confirmed. In some of the cases, however, the bacteriæmia persists after operation. When the surgeon is certain that the bone lesion has been so thoroughly removed as to be impossible of causing the bacteriæmia and when the appearances of the bone wound corroborates this impression, the bacteriæmia should be used as an indication that some other focus exists which must be found and removed in order to render the blood sterile. Many

times this proves to be the case; but when it does not, the original focus should be examined again and revised operatively if possible. If the bacteriæmia still persist and the number of demonstrable bacteria is still comparatively small, the explanation of the bacteriæmia cannot be decisive, because in epiphyseal foci radical removal of the entire focus must necessarily be frequently incomplete for the reasons just indicated. In the meanwhile other foci should be looked for constantly during the continuation of the bacteriæmia. Fortunately in most of these cases the natural forces of the body are ample after a sufficient lapse of time to render the blood sterile.

B. When several foci of osteomyelitis coexist in the presence of a bacteriæmia, the explanation of the latter becomes a matter of exclusion. Similar rules to those outlined in the last paragraph apply.

C. In many of the cases of acute epiphysitis—especially in those which follow the mastoid-sinus-thrombosis cases—the primary lesion is demonstrable as well as one or more subsidiary bone lesions. In the majority of the cases the bacteriæmia disappears after efficient surgical treatment directed toward all of the demonstrable lesions primary or other. In a few cases, however, the bacteriæmia persists, although in some of the latter cases, because of the character of the primary lesion or of the infecting organism, or because of other reasons, it is possible to say with a fair degree of certainty that the primary lesion is keeping up the bacteriæmia. In all of the others the proper explanation becomes a matter of exclusion also in accordance with the rules laid down.

D. In some of the cases of acute epiphysitis with bacteriæmia, a subsidiary focus has developed in a tissue or organ other than bone, or a complication develops which is unrelated to the epiphysitis. Except in those cases of complication in which the latter is known from previous experience to cause a bacteriæmia or general blood infection, the proper explanation again becomes a matter of exclusion as previously indicated.

E. In any case in which the question of the bacteriæmia cannot be adequately explained and in which it continues to exist an endocarditis should be looked for. The presence of the latter is the most serious complication possible and a very grave prognosis should be made; operation on any local focus is futile in the presence of a bacterial endocarditis and a fatal outcome should be expected.

Patients in the first four groups of this classification may at any time progress into the group of most severe and fulminant cases. They assume characteristics of the cases in this group and the clinical manifestations increase in gravity proportionately and absolutely. Similarly therapeutic indications exist as were previously pointed out. It is very rare for the opposite course to be followed. This change has intimate relation with a spread of the thrombo-phlebitis as previously referred to and may occur spontaneously either before or after operation or as a consequence of the latter. The possibility of this change occurring spontaneously before operation in cases of any form of acute osteomyelitis, even when previously a sterile blood culture

had been obtained, is the chief reason why authorities consider cases of acute epiphyseal infections emergency cases which brook of little or no delay before operation.

In performing the secondary sequestrotomy only as much healthy bone or—involucrum—should be removed as to enable one adequately to remove the sequestrum. The main care is not to cause undue mutilation and to prevent the spread of the thrombo-phlebitis inasmuch as this is the chief cause for the subsequent exacerbations or recrudescences in the same focus or in the production of other foci. The resulting wounds should not be sutured and should be allowed to heal from the bottom either with or without the aid of sterilization by the Carrel-Dakin method. The presence of exposed joint surfaces and the desire not to increase the damage or injury already existing within the given joint, or the risk and danger of opening into the joint during the sequestrotomy, are frequent handicaps to the surgical technic. In some cases the risk must be disregarded in the endeavor to cause the surgical wound to heal; this will necessarily be so when sinuses already exist which lead into the interior of the joint. In other cases, with intact and uninfected joints, and even in others where an exudate of some kind is present in the joint, a conservative policy may be permitted and may even be advisable; I believe that the latter goes a long way toward an increased conservation of joint function.

The experiences upon which the deductions of this communication are based are derived from the study of clinical cases admitted to the service of Doctor Moschcowitz and in my own private practice. I am indebted to Doctor Moschcowitz for permission to carry on these studies upon the patients admitted to his service.

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THE RECONSTRUCTION OPERATION FOR DEFORMITY SECONDARY TO DISEASE AT THE HIP-JOINT

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In the Annals of Surgery for December, 1924, and June, 1925, I described a modification of the reconstruction operation, originally, designed for ununited fracture of the neck of the femur,[1] as adapted to the treatment of advanced arthritis deformans at the hip-joint.

It was noted as characteristic of this disease, that irrespective of its exciting cause, the progress of the destructive process in the joint was determined by the friction of the irregular surfaces of the femur and acetabulum on one another, and by the weight and strain to which the weakened part might be subjected.

Fig. 1.—Shows the destructive changes in the joint, secondary to incongruity in childhood; particularly the impingement of the trochanter on the ilium and the obliquity of the acetabulum. The compensatory upward tilting of the pelvis is also shown.

The object of the operation was to reduce this destructive attrition by lessening the area of contact and transferring it from the outer to inner part of the acetabulum.

The joint having been exposed and the deformed femoral head extruded, it was completely reshaped, the greater part being removed together with all the degenerated cartilage, leaving a smooth, rounded extremity of about the diameter of the neck. The trochanter was cut through at its base and transplanted to the outer surface of the shaft at a sufficient tension on the attached muscles to hold the limb in a moderate degree of abduction. This permitted the remodeled extremity to be thrust deeply into the acetabulum where the cartilage as contrasted with that about its outer margin was in fairly normal condition.

By this form of arthroplasty one might relieve the symptoms, check the progress of the disease and yet preserve a useful range of motion.

This type of operation has been employed in a number of other conditions, three of which are presented as of interest from several points of view.

[1] *Surgery, Gyn. and Obstetrics*, June, 1921.

The first patient, a man now thirty-two years of age, was seen when a child in 1901. He then according to the record presented the characteristic physical signs of coxa vara, and as it was stated that he had always limped, it was thought that the deformity might be of congenital origin.

The depression of the neck was corrected by a cuneiform osteotomy at the base of the trochanter. This operation, according to the mother relieved the symptoms and he was not seen again until November, 1926. He stated that he had had but little disability until during the past year when the limp had become more noticeable and the local discomfort more persistent.

FIG. 2.—After operation—showing, as contrasted with figure one, the changed relation of the transplanted trochanter to the ilium and the symmetry of the new bearing surface.

He was in good physical condition. There was a marked limp on the left side. The trochanter was elevated. The limb was adducted and the compensatory tilting of the pelvis caused an apparent shortening of two and a half inches. The range of flexion and extension was also somewhat restricted and forced movement caused pain.

The accompanying X-ray picture shows an extreme degree of coxa vara with distortion of the head. It may be noted that the trochanter is in close apposition to the pelvis, completely checking abduction, which is still further restricted by a projection of bone from the base of the neck. The appearance of the joint when exposed at operation was similar to that of arthritis deformans. The upper surface of the head and neck resembled somewhat the back of a spoon. The roughened, irregular cartilage formed excrescences about its lateral borders and there were several loose cartilaginous bodies in the joint. The distorted head was reshaped with a chisel and file into a smooth, rounded extremity and the

trochanter transplanted in the usual manner as shown in the second X-ray picture taken through the plaster soon after operation.[2]

It may be noted that the trochanter, formerly in contact with the pelvis, now stands at a sufficient distance from the acetabular rim to permit a full range of abduction, and as the new head is solid and symmetrical the progress of the destructive process should be checked.

The second case is of a similar type, although of a different cause.

The patient, a woman thirty-five years of age, was first seen in January, 1927, the

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FIG. 3.—Case II. This shows what resembles an epiphyseal fracture. The impact of the neck with the view of the acetabulum prevents the reduction of the adduction deformity.

FIG. 4.—Case II. After the reconstruction operation. The distorted head has been removed and the extremity of the remodeled neck placed in the acetabulum.

physical signs and symptoms corresponding closely with those of the case already described.

It was stated that when she was twelve years of age she had been confined to bed for several months by so-called rheumatism of the hip. After recovery, except for the limp, she had suffered comparatively little inconvenience. Within the past three years, however, there had been increasing discomfort and disability, chiefly awkwardness and insecurity.

It may be noted in the X-ray picture that the appearances resemble those of an old fracture of the epiphyseal type, the projecting angle of the neck impinging on the acetabular rim checking abduction completely. This may have been a direct effect of injury but more probably the displacement was secondary to disease.

On February 7 of the present year the reconstruction operation was performed. The head of the bone was found to be much distorted, the cartilage presenting the typical appearances of arthritis deformans, thus accounting for the pain on movement of the joint.

[2] The operation is indicated in advanced cases of Legg-Perthes disease for the removal of the degenerated and distorted epiphysis.

These cases are of interest in their bearing on the etiology of arthritis deformans, illustrating how a so-called incongruity of the joint in childhood may induce changes in later years closely resembling those of primary disease.[2]

The third case was a direct result of disease. The patient, a woman thirty-five years of age, the daughter of a physician, had been treated for tuberculosis of the hip-joint for many years during later childhood and adolescence. She recovered eventually and according to her statement there had been but little disability until during the last

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FIG. 5.—Case III. This shows the destructive effect of the original disease, the upward tilting of the pelvis and the contact of the trochanter and acetabular rim.

FIG. 6.—Case III. Taken through the plaster spica after operation. Shows the abduction of the limb made possible by removal of the trochanter.

year when the limp and deformity had increased, and it was on this account rather than because of pain that treatment was desired.

The limb on the affected side was flexed and adducted as in the preceding cases, though to a more extreme degree, the apparent shortening due to compensatory tilting of the pelvis being four inches.

The X-ray picture shows the destructive effect of the primary disease. The acetabulum is enlarged and the bearing surface of the femur has been reduced to a finger-like projection, which with the increasing adduction of the limb has become more unstable as a support. The relation of the trochanter to the acetabular rim is such as to check abduction absolutely demonstrating clearly that its removal is essential to the reduction of the deformity.

The operation was performed on February 28 and the picture taken through the plaster shows that the adduction deformity has been corrected and that the former

[2] This point is best illustrated by the Legg-Perthes disease and congenital dislocations and subluxations at the hip.

bearing surface, supplemented by the area obtained by removal of the trochanter now contained within the acetabulum, forms a secure support.

These cases are presented, not to illustrate the results of treatment, but to demonstrate the mechanics of the reconstruction operation. The distinctive features that justify the name reconstruction being transplantation of the trochanter; to remove a direct mechanical obstruction to the reduction of deformity, to provide a new bearing surface and a wider range of lateral motion, and to restore the leverage of the abductor muscles.

The purpose of the reconstruction operation in design and in supplemental treatment is to provide a sufficient range of abduction to restore symmetry and to assure stability.

The plaster spica applied at the operation in extension and about 20° of abduction is usually retained for about a month, when it is assumed that the transplanted trochanter will have become united with the shaft. If the patient remains in the hospital the limb is suspended from a frame for passive movement and muscular reëducation. In other cases a short spica is applied and the patient is permitted to walk about with or without crutches as may be indicated by the degree of discomfort.

In cases of the types under consideration, in which the deformity is of long standing, there is always a tendency toward a relapse to the former attitude. Therefore in the after-treatment, daily, methodical, manual "stretching" of the limb to the attitude of extension and abduction in which it was fixed at the time of the operation must be continued until the patient is able to carry out the movements voluntarily.

This point is emphasized because its importance is not generally appreciated. One often sees patients presented as successful results of bone-pegging for ununited fracture at the hip or as illustrating restoration of motion after arthroplasty for ankylosis, in which the range of abduction is absolutely restricted. I conclude, therefore, that transplantation of the trochanter should supplement any form of operative procedure in cases of this class.

As has been stated the reconstruction operation was originally designed for the treatment of ununited fracture at the hip, but in recent years it has opened a larger field in the treatment of arthritis deformans. In these cases of confirmed so-called malum coxæ senilis the disabling symptoms are caused by friction of the irregular and roughened surfaces of the joint upon one another. It is evident, therefore, that neither internal medication nor local applications can have any material influence on the progress of the disease except in so far as they are combined with rest. Furthermore, as splinting of this articulation for indefinite periods is impracticable operative intervention offers the only effective remedy. Formerly there was no alternative to arthrodesis. This operation was by no means always successful and as patients strenuously object to a "stiff" joint it has been restricted to advanced cases. The reconstruction operation has therefore the great advantage that

since it is designed to improve function it may be utilized to forestall the long period of painful and progressive disability.

The operation as adapted to arthritis deformans was first described in 1924 (ANNALS OF SURGERY, December, 1924). At that time seven cases were reported, since then thirty-six others have been operated on by this method at the Hospital for Ruptured and Crippled.

It is, of course, evident that in cases of this type it is impossible to restore the normal condition. The results, however, from a comparative standpoint, have been very satisfactory, and as symmetry has been restored and the destructive attrition reduced, one may fairly count on permanent improvement.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held March 7, 1927

The President, Dr. Charles F. Mitchell, in the Chair

APPENDICITIS WITH NON-DESCENT OF THE CÆCUM

Dr. Searle Lanyon, by invitation, presented the history of a patient who had been under the care of Dr. Hubley Owen, at the Philadelphia General Hospital. A man was admitted to the Special Surgical Ward of the Philadelphia General Hospital on November 1, 1926, with the chief complaint of abdominal pain localized in the right upper quadrant associated with nausea and occasional attacks of vomiting. Two years prior to his admission to the hospital he had an attack of severe colic in the right upper quadrant of his abdomen. This continued for a day or two and gradually disappeared. Six months after this attack he had a second attack of the same character only more pronounced. Most of his pain was confined to the right upper quadrant with occasional pain in the lower right quadrant. In the beginning the pain was very sharp. Later he described it as being "a dull, aching pain." He did not vomit and felt nauseated. This second attack continued for about two days. One month later he had another attack which was practically the same in its manifestations as the previous two attacks. Following this the attacks became more and more frequent. In August, 1926, he states he had an attack of jaundice. A week prior to his admission he had another severe attack of pain in the right upper quadrant of his abdomen associated with jaundice and persistent vomiting. The pain had no relation to the time and type of nourishment. He frequently took sodium bicarbonate without relief.

The man was white, thirty years of age, well developed, well nourished. His abdomen was soft and flaccid. Liver and spleen were not palpable. No palpable masses. There was subacute tenderness over McBurney's point, also the upper right quadrant in the region of the gall-bladder.

Urine showed no abnormality. Blood count showed 7400 leucocytes. Red count and hæmoglobin normal. Wassermann, negative. Blood sugar was 80. Blood urea, 13. Blood uric acid, 4. Vandenburgh was negative. Icteric index was 6.

X-ray examination showed the greater curvature of the stomach situated 10 cm. below the iliac crest. It was of the fish-hook type. Peristalsis was normal. Conus was normal and no filling defects. The head of the barium column was at the hepatic flexure in six hours. In twenty-four hours practically all of the barium had been evacuated but some was still remaining at the cæcum. The ascending colon was not demonstrable in the lower right quadrant of the abdomen. It appeared as though the ascending colon was in the right upper quadrant of the abdomen. The appendix was not visualized. No evidence of organic lesion of the stomach or duodenum.

November 8, a McBurney incision was made. No large intestine was found in the right iliac fossa. The incision was enlarged upward along the outer border of the rectus muscle by splitting the anterior sheath of the rectus muscle and retracting the right rectus muscle toward the midline. The

cæcum was located below the liver. The appendix was kinked on itself and was bound to the liver and gall-bladder by a number of adhesions. The appendix was removed. The gall-bladder showed no pathology. Following the operation the man returned to the ward in good condition. Temperature, pulse and respiration remained normal. Stitches were removed on the seventh day and the patient was discharged from the hospital November 19, 1926.

Cases of non-descent and non-rotation of the cæcum present a number of interesting features from the clinical as well as from the embryological standpoint. The presence of intra-abdominal pain and tenderness in certain locations is taught as a guide to diagnosis. Unusual cases such as the one herewith reported show a variety of symptoms which are instructive nevertheless misleading.

Since operating on this case the reporters have made X-ray studies after a barium meal in a number of cases of subacute and chronic appendicitis and have found that the cæcum is frequently high in the right upper quadrant due to its failure of descent. This has been useful as a guide for the incision in such cases.

URETERO-COLONIC FISTULA

Dr. Lloyd B. Greene, by invitation, reported the case of a woman, age thirty-eight, who was admitted to the Pennsylvania Hospital, April 19, 1926, with the chief complaint of pain in the back. Ten years ago the patient had an attack of acute pain in the right lumbar region. This lasted one hour, during which time she passed cocoa-colored urine. The pain subsided and the urine became clear. There were a few strands of material that she thought were blood. One month later, there was a second attack similar in every detail and the third attack one month later. The only treatment consisted in diuretic pills. Three months after this onset she had a fourth attack of pain, after which she passed a brown stone about ⅛ inch by 1¼ inches. The stone resembled a date stone. Following this she was free from symptoms for a period of six years when right lumbar pain recommenced. The pain was now dull in character, lasted about twenty-four hours, and radiated to the right anterior portion of the abdomen. Following the painful attacks she noted a heavy feeling in the bladder which lasted two days. For the three months preceding admission to the hospital the painful attacks and the heavy feeling in the bladder were followed by the passage of cloudy urine. The urine clears up promptly and she is again quite comfortable until the pain in the right lumbar region recurs. The pains have never been referred to the groin and they have always been on the right side. The attacks have been irregular, sometimes weekly and sometimes once in four or five weeks. The last attack was four days before admission. The patient gave a history of having had three abdominal operations; the first for pelvic inflammatory disease; the second for some unknown condition; the third for a tumor of the right upper quadrant. She has not menstruated since the first operation, five years ago. Following her marriage she had fifteen miscarriages in a period of four years and then three normal children. Routine examination revealed nothing unusual. The urine was loaded with pus. The phenolsulphonephthalein test showed elimination of 25 per cent. of the dye in the first hour and 15 per cent. in the second. Cystoscopic examination revealed the following: Bladder contained slightly cloudy urine. Capacity normal. Bladder very tolerant. There was some slight cystitis. The right ureteral orifice appeared ragged, swollen and œdematous. There was no ulceration in the ureteral area, but considerable inflammation. The left ureteral region was normal. No. 6 F. catheters passed to the normal level

of each kidney pelvis without any difficulty. Normal flow of urine from the left catheter—urine slightly blood-tinged but otherwise grossly normal. Nothing was obtained from the right catheter until after the injection of sterile water, when a large quantity of pus was aspirated. The pus was too thick to come away spontaneously, and had an exceedingly foul odor. The differential phthalein test showed appearance time from the right kidney—none in twenty-five minutes, and from the left—four minutes—full concentration. Percentage output: Right—none in one-half hour period; left—17.5 per cent. in fifteen minutes. Pyelogram—right kidney—syringe method. After extracting as much pus as possible, 100 c.c. of 12.5 per cent. solution of sodium iodide was introduced without pain. Stereoscopic plates taken. The specimens of urine obtained by ureteral catheterization showed: Right—cloudy, acid—loaded with pus, few red blood-cells, few organisms, culture shows streptococcus indifferens. Left—clear, acid—few red blood-cells, no pus cells, no organisms, culture sterile. X-ray of the genito-urinary tract revealed a shadow which is properly in line for the position of the right ureter and on about a level with the lower border of the fourth lumbar vertebræ. This is of considerable size, some 7 or 8 mm. in diameter, and fully 2 cm. in length. There is good reason to suppose that this shadow may be in the ureter.

In a right pyelogram the same shadow is seen closely contiguous to the catheter. There is a hydronephrosis with a defect on the lower, renal aspect of the pelvis, which indicates the pressure of some body pressing upward and outward into the pelvis, or against it. The most striking feature of the examination, however, is the entrance of the iodid solution directly into the cæcum and ascending colon. There can be no question as to the presence of a reno-colonic fistula.

After a barium injection no abnormality of the fillings of the colon could be seen under the fluoroscope; but, after the fluoroscopic examination, the patient was removed to the table and stereoscopic films made which show a very distinct dilation about the cæcum, and it would appear that the fistula must connect with the posterior aspect of either the cæcum or the very lower portion of the ascending colon. The colon enema was accomplished without any unusual feature of any kind.

The patient was operated upon by Dr. Leon Herman and Dr. Charles F. Mitchell on April 29. The incision extended from the lumbar triangle to a point one inch below umbilicus and one inch to the outer side of the semilunar line. Relatively small kidney palpated rather low in position and surrounded by thickened and very dense organized scar tissue. The outer border of the kidney and its upper pole were rather easily mobilized, but the lower pole and the pelvic area were densely adherent. The ureter was felt as a greatly thickened, rigid cord about one and one-half inches in diameter. The tissue around the ureter was broken through, but it was found impossible to mobilize the tube. The lower pole of the kidney was freed but could not be brought up into the wound. This prevented visualization of the fistulous tract which was apparently situated at the upper end of the ureter at or near the uretero junction. It was at first thought necessary to amputate the kidney from the pelvis, but a line of cleavage was found between the peripelvic scar tissue and the thinned-out pelvic wall which permitted the placing of clamps so that most of the pelvis could be removed with the parenchyma. On the surface of the tissue that had been separated from the anterior surface of the pelvis, a small necrotic area suggestive of a sinus was seen, but this would not admit a probe and the operators finally concluded that it was not the fistulous opening. The area was surrounded by a purse-string suture

and oversewed. The pedicle was transfixed under each clamp and tied. On examination of the kidney, which represented a pyonephrosis, not any larger than, if as large, as a normal kidney, the parenchyma was found to be intact. On the anterior surface of the pelvic wall was a small round hole which was taken to be of traumatic origin. The final conclusion was that the kidney with the major portion of the true pelvis had been removed and that the fistulous communication was situated below the level of amputation, that is in the very lowermost portion of the true pelvis or in the ureter. The major part of the inflammatory reaction as evidenced by the great mass of scar tissue especially around the proximal portion of the ureter, tends to support this view.

Pathological report: The kidney is small with irregular pale granular surface. The specimen weighs 60 grams and measures 9 x 4 x 3.5 centimetres. The pelvis is dilated, walls thickened and mucosa hemorrhagic and covered with slight purulent exudate. Considerable fat is present in the renal parenchyma and a few small abscesses are present throughout. Practically no normal architectural arrangement is noted and homogeneous pallor extends throughout.

Microscopical Examination.—The glomeruli are hyalinized. The tubules are few in number, epithelium is narrow. Diffuse fibrosis extends throughout with obliteration of renal substance. The vessel walls are thickened. Foci of round cells, the centres of which are necrotic and many clumps of polymorphonuclear cells are scattered throughout. In a few places there is proliferation of blood-vessels in loose infiltrated granulation tissue. A few pleomorphic bacilli are scattered in the midst of infiltrated areas.

Diagnosis.—Extensive pyelonephritis.

The post-operative convalescence was somewhat prolonged as would be expected. Five days after the operation, there was noted some fæcal discharge from the wound. This was of very short duration. The patient was discharged to the dispensary on June 2, 1926. She was readmitted to the house on September 9, 1926, because of the unusually large quantity of purulent drainage from the sinus. She was feeling quite well and had no other symptoms.

The sinus was injected with an opaque solution and stereoscopic plates were taken. The capacity was 15 c.c. Doctor Bowen reported as follows: "The fistula followed to the depth of the normal kidney pelvis, where there is an ampulla one and one-quarter by two cm., densely filled. There is a small diverticulum from this, extending inward and backward for about two cm. Somewhat further down, in the line of the ureter and at the level of the lower half of the fourth lumbar vertebra, there is a semi-dense oval shadow, some three cm. in length, which would appear not to be due to injected fluid. Under ordinary circumstances we would first think of a large ureteral calculus containing a rather small amount of calcium.

The patient was finally discharged October 13, 1926. The sinus was less than an inch in depth and the discharge had practically ceased.

Dr. J. L. Herman called attention to the relationship of the ureteral catheter to the shadow cast by the injected medium. In the flat plate it would seem that the tip of the catheter had entered the colon, but this is only apparent. As seen in stereoscopic films, the tip of the catheter is situated at least one-half inch from the diverticulum of the cæcum, which latter was placed over the renal pelvis, this being in all probability the site of the fistula.

Stereoscopic films alone are of major importance in the diagnosis of these conditions. The speaker rarely makes flat plates in pyelographic work.

The operation was difficult chiefly because of very dense adhesions at the uretero-pelvic region, and very great thickness of the upper ureter, which facts indicate the site of the fistula as being in the lower portion of the pelvis or upper ureter. Following the operation, a small temporary fecal fistula developed, probably due to trauma rather than to exposure of the fistulous tract at the time of operation. The kidney and major portion of the renal pelvis were removed, but it is questionable if the site of the fistula was disturbed. The patient has made a satisfactory recovery, but it may be that the ureter and cæcum are still connected by a fistulous tract. Cystoscopic findings seemed to rule out the presence of stone. Whether the fistula resulted from injury at the time of the abdominal operations cannot be determined with certainty.

PULMONARY ACTINOMYCOSIS

Dr. P. A. McCarthy, by invitation, reported the case of a woman, aged twenty-eight, who was admitted to the Mental Department of the Philadelphia General Hospital, August 29, 1925, with a diagnosis "manic-depressive insanity." She died March 26, 1926. In September, 1925, there was first noted a small tumor overlying the fifth rib in the right mid-axillary line. The tumor was painless and was attached to the rib. On October 1, 1925, excision was made. A pathological diagnosis of "chronic suppurative inflammation" was made. X-ray of ribs and lungs showed no abnormal findings. The wound did not heal. On November 4 smear from the wound discharge was positive for actinomycosis. On January 2, 1926, she came under the care of Dr. Hubley R. Owen. The patient was extremely emaciated and complained of severe pains in lower abdomen and lower extremities. Over the fifth and seventh ribs mid-axillary line and tenth rib mid-scapula line, were small scars at the centres of each of which was a small sinus exuding a gray glutinous material. The infected tissues were adherent to the underlying chest wall. The neurological symptoms became rapidly more severe, including pain in the abdomen and lower extremities. The left leg became gradually paralyzed. The right leg manifested a progressive weakness; marked hyperæsthesia over both extremities. X-rays of chest and vertebræ negative. Ray fungi were demonstrated from the skin lesions. During subsequent weeks, patient's condition became progressively worse. Pain in lower extremities became so excruciating that she begged for operative interference.

Operation.—March 25, 1926, by Doctor McCarthy, after transfusion of 500 c.c. citrated blood. A laminectomy was done involving the eleventh and twelfth thoracic vertebræ and first lumbar. The laminæ of the twelfth thoracic vertebra were very friable and rough. The dura was thickened, densely adherent, very tense and covered with tissue resembling granulation tissue. When the dura was opened, a large quantity of cerebrospinal fluid escaped. The cord was not involved. At close of operation, patient was in fair condition. Death supervened suddenly twenty-four hours later.

At post-mortem: The most marked pathology was found in the right lung, which was infiltrated with fibrous tissue toward its base. In the centre of this fibrous tissue was a necrotic area about size of a walnut containing gray, red glutinous material with flocculent granules. The necrotic process extended down to and involved the diaphragm. This necrotic process also involved

the parietal pleura from the fifth to the tenth ribs and extended along the eighth, ninth and tenth ribs posteriorly and involved the lateral processes and bodies of the vertebræ and the dura. In the necrotic area of the lung, actinomycotic fungi could be demonstrated. No fungi were found in the liver or diaphragm. The brain was negative; spinal cord tracts normal; spinal meninges infiltrated with round cells.

Doctor McCarthy was of the opinion that this case probably originated in the lung and extended by contiguity to the pleura, ribs, skin and vertebræ while the affection of the meninges produced the compression symptoms noted.

Pulmonary actinomycosis is usually not recognized until the chest wall is penetrated and the fungus is found in the discharge. Primary involvement of the nervous system by actinomycosis is rare. Every inflammatory swelling of the thorax wall, subacute or chronic, with persistent and recurring sinus formation, should be carefully investigated for the presence of actinomycosis.

Dr. John Speese said that during the past winter a girl, seven years of age, was admitted to the Children's Hospital with symptoms suggestive of empyema. The X-ray showed a shadow over the left base which was suggestive of a thickened pleura or fluid. Several exploratory tappings were negative. Finally the chest was opened, no fluid was found, and the sinus which resulted did not heal. It was thought at one time that the child had tuberculosis and the actinomycosis was only recognized when scrapings from the deeper parts showed the fungus. A second exploratory operation revealed the very extensive character of the disease which involved the pericardium and mediastinum; ultimately the child died. The father of the patient was a fruit dealer and the child was accustomed to play about the floor, which contained a great deal of straw. It was believed that the fungus probably gained entrance to the air passages from this infected material.

Dr. G. M. Dorrance remarked that he had seen two cases of actinomycosis during the past year at the Philadelphia General Hospital. One case involved the tongue. The speaker called attention to the fact that this condition is often mistaken for cancer when seen about the jaws or tongue.

CARCINOMA OF THE RECTUM

Dr. John H. Jopson presented a woman, twenty-six years old, who was referred by Dr. George Outerbridge to the speaker's service in the Medico-Chirurgical Hospital, suffering from bleeding from the rectum, pain in the lower abdomen, in the middle of the abdomen and in the back. Her general condition was not good. X-ray examination revealed a napkin-ring construction of the pelvic colon, 5 cm. in width and 8 cm. above the anus. It was patulous to an opaque enema. The pelvic colon was elongated. The patient was subjected to the usual procedure as systematized by Dr. Daniel Jones, of Boston. Recto-sigmoid growths offer a difficult problem and Doctor Jopson believes that this operation offers the best anatomical and physiological approach. The first stage of the operation was done June 1, 1925, and included colostomy, mobilization of the descending colon and peritonealization. The second stage was done June 12 and consisted of removal of the rectum and perirectal tissues from below. Pathological examination confirmed the diagnosis of adenocarcinoma. She was discharged on August 11, 1925, since which time her general health has been excellent. She has returned to her occupation as a secretary and is perfectly well.

CARCINOMA OF THE RECTUM

Doctor Jopson presented a second patient, a man aged thirty-seven, who was admitted to his service at the Medico-Chirurgical Hospital in March, 1926, complaining of bleeding from the rectum and constipation. The symptoms were of several months' duration and were attributed by the patient to a "strain". A physician had treated him for hemorrhoids, but repeated hemorrhages and an increasing amount of blood finally brought him to a proctologist, who at once recognized the condition as carcinoma and referred him for operation. On admission a mass was felt in the rectum about three inches from the anus. The growth was hard and extended on to the anterior surface. There was considerable constriction present. Introduction of a speculum was followed by escape of gas and mucus.

Except for a fairly severe secondary anæmia, the examination was otherwise negative. Careful examination, including X-ray, failed to show evidence of metastases. Operation was performed in two stages, the first stage on January 11, followed by the second stage in one week. The procedure was the same as in the preceding case, *i.e.*, by the abdomino-perineal method of Jones. The mistake was made in this case of completely cutting off the marginal artery at the first stage, which resulted in gangrene of the lower loop of bowel. The gangrenous process was so extensive that the patient developed a large fistulous tract extending from the abdominal wound into the perineum. The tract was "Dakinized" and healing by granulation took place. A large amount of blood was lost at the operation, which prolonged the convalescence, but the final result was excellent. He was discharged from the hospital on March 22, ten weeks after the first operation.

The speaker believes that it is not wise to attempt closure of the large perineal wound in these cases, but prefers to "Dakinize" and allow healing by granulation. The patient is thus saved much in the way of absorption and fever. This patient has a well-functioning colostomy of the "single-barrel" type, due to the sloughing out of the lower loop. He returned to work on May 22, 1926, and has been working ever since.

Both of the patients presented by Doctor Jopson have had careful and systematic post-operative X-ray treatment at the hands of Dr. George Phaler. Both have the simple form of colostomy, the speaker having found that the more complicated fail to give as great satisfaction.

PRINCIPLES UNDERLYING THE SURGERY OF CARCINOMA OF THE RECTUM

Dr. Damon B. Pfeiffer pronounced the annual oration on the above entitled subject.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held March 9, 1927

The President, Dr. Walton Martin, in the Chair

PROGNOSIS IN GIANT-CELL SARCOMA

Dr. William B. Coley presented a group of cases illustrating the cure of giant-cell sarcoma by different methods of treatment. In presenting Case I, one of his earlier series of cases, Doctor Coley remarked that he believed he was one of the first surgeons to advocate the conservative treatment of sarcoma of the long bones, particularly central sarcoma of the giant-cell type.

Case I.—*Myelosarcoma (giant-cell) of tibia, recurrent; treated by curettage, toxins and X-rays. Patient well twenty-three years later.* K. K., female, aged seventeen years, was referred to Doctor Coley by Dr. V. P. Gibney in October, 1904, with the following history: The patient had been treated at the Presbyterian and the Post-Graduate Hospitals as a case of tuberculous disease of the lower end of the tibia. The leg had been put in a plaster-of-Paris splint in September, 1904; and the patient was unable to walk. A large soft swelling was found over the internal malleolus, with slight effusion into the joint. An operation was performed at the Hospital for Ruptured and Crippled on October 11, 1904, by Doctor Gibney assisted by Doctor Coley. At this time, eight ounces of thick, reddish-brown, soft material was removed from the lower end of tibia. The entire lower third of the tibia was, apparently, involved, and only a thin outer shell remained. The ankle-joint was not involved. A section was examined microscopically, and pronounced myelosarcoma (giant-cell).

On January 3, 1905, a large local recurrence had developed and a second operation (curettage) was performed. The patient was then given systemic toxins combined with X-rays. At the end of five months she was discharged. Regeneration of bone had taken place in the destroyed area of the lower end of the tibia; and the patient had a perfectly useful limb. She remained in good condition, with the exception that, about ten years after treatment, when she developed an ulcer at the site of an X-ray dermatitis, which failed to heal under treatment, and necessitated scraping and skin-grafting. At the present time, twenty-three years later, the patient is in excellent condition with no evidence of a recurrence.

Case II.—*Central sarcoma of lower end of femur, giant- and spindle-cell, with extensive involvement of the knee-joint, treated with toxins alone. Limb saved. Patient well twelve and one-half years later.* For a more full report of the following case see the Annals of Surgery, December, 1919. L. G., female, aged nineteen years, was admitted to the Hospital for Ruptured and Crippled on October 24, 1914, with a tumor of the lower end of the femur with extensive involvement of the knee-joint, which had been treated for tuberculosis at various other hospitals. An exploratory operation was per-

formed by Doctor Coley but no attempt was made to curette the large tumor. Sections were examined by various pathologists who reported as follows: Mixed-cell sarcoma (Dr. F. M. Jeffries), malignant giant- and spindle-cell sarcoma (Dr. F. C. Wood), sarcoma, malignant (Doctors McCarty and Broder, Mayo Clinic and giant- and spindle-cell sarcoma (Dr. J. Ewing). In a later report, Doctor Ewing stated: "The tumor was not histologically benign; I merely mean it was not extremely malignant." According to the Bone Sarcoma Registry, this tumor was classified as a benign giant-cell sarcoma.

Doctor Coley stated that an amputation was advised but refused by the patient. The toxin treatment was then begun and continued for nearly a year. Immediate improvement was noticed, which continued until complete recovery had taken place. Doctor Coley stated that, regardless of the histological type of the tumor, he does not believe there is another case on record of such an extensive tumor of the femur with involvement of the knee-joint, that has been cured by any method of treatment without amputation.

The later developments in this case are of interest: In the latter part of 1922, a tumor appeared in the right breast and was removed by operation. The clinical and microscopical diagnosis was that of fibro-adenoma. About eight months later, another tumor developed in the same breast at the site of the old scar. This grew with somewhat greater rapidity than the previous tumor, and about three months later, a small nodule, the size of a cherry, appeared one inch above the main tumor and separate from it. This nodule was firm in consistence, but not hard, while the larger tumor was soft, apparently cystic, and resembled a cystadenoma. Both tumors were removed by operation by Doctor Coley. Several sections were submitted to various pathologists who at first found great difficulty in making a diagnosis between carcinoma and sarcoma but who later reported as follows: Sarcoma (Doctor Jeffries); carcinoma (Doctors Ewing and Wood). The macroscopical appearance of the tumor and the rapidity of its growth, associated with the early age of the patient, inclined Doctor Coley to regard it clinically as sarcoma; but in view of the pathological diagnosis he believed the case might be regarded as another example of a rare condition, that is, two different types of malignant tumor developing in the same individual after a longer period of time. The patient is in excellent condition at the present time with no evidence of a recurrence, twelve and one-half years since the time of Doctor Coley's first observation, and three years since the removal of the malignant tumor of the breast. It is interesting to note that only a local removal of the breast tumor was made, and the axilla was not opened. The toxins were given for four months in addition to prophylactic X-ray treatment.

Case III.—*Giant-cell sarcoma of femur apparently cured by a combination of operative and X-ray treatment. Patient well two years later.* I. H., male, aged thirty-six years, was admitted to the Memorial Hospital on January 9, 1925, with the following history: Patient's family history negative. During the years 1917 and 1918, while in the Navy, the patient fell several times, bruising his left knee. In the winter of 1921, he felt severe pain in the knee; this was relieved by bandage and electric treatment. One year later the symptoms returned and did not respond to the same treatment. He was admitted to Bellevue Hospital where an operation (partial removal of the condyle) was performed by Doctor Hartwell and Doctor Dudley on June 19, 1923. A section was examined microscopically by Doctor Ewing and pronounced benign giant-cell sarcoma. The patient wore a splint for fifteen months. The pain returned and was associated with considerable stiffness and tenderness at the

right knee-joint. At the time of his admission to the Memorial Hospital, an X-ray picture was taken which showed: "The outline of the resected internal condyle of the femur to be irregular, and the appearance suggestive of the presence of active tumor growth in the adjacent medulla and cortex of bone." He was treated with high-voltage X-rays by Doctor Herendeen, six treatments being given between January, 1925, and August, 1925. The pain has entirely disappeared; recent X-ray pictures show further laying down of new bone; and, with the exception of a slight limp, the patient is in excellent condition at the present time, more than two years later.

CASE IV.—*Giant-cell sarcoma of head of tibia, treated by curettage and carbolic acid. Patient well two years later.* N. P., male, aged forty-four years, was admitted to the Hospital for Ruptured and Crippled on April 25, 1925, complaining of pain and swelling about the right knee, which condition was of two years' duration. Examination by Dr. Royal Whitman revealed a tumor about the size of half an orange, situated on the outer and upper side of the tibia extending back to the head of the fibula. There was no interference with the action of the knee-joint. An X-ray picture taken at this time showed a large cystic tumor beneath the head of the tibia; the walls of the tumor were extremely thin; and it apparently communicated with the knee-joint at its outer margin. There was no sensitiveness to pressure. The diagnosis made was that of cystic tumor or a giant-cell sarcoma.

On April 27, 1925, Doctor Whitman made an oblique incision just above the head of the fibula downward and forward for about five inches; the wall of the tumor was thick; when partly removed it opened a cavity communicating with the head of the tibia. This cavity contained yellowish cheese-like masses and reddened grumous tissue both in the sac and in the cavity of the head of the tibia. The walls were not lined with connective tissue, but displayed a roughened and yellowish eroded surface. The knee-joint was opened and all the tissue that remained was the cartilage entirely separated from the bone. The wound was packed. Microscopic diagnosis: Giant-cell sarcoma.

On June 20, 1925, the patient was discharged, wearing a brace, and holding the limb in full extension. The cavity was clean and evidently closing from the bottom. At the present time, nearly two years later, the patient is still in good condition with no evidence of a recurrence.

CASE V.—*Giant-cell sarcoma of femur (clinical and X-ray diagnosis), treated with radium alone; apparent cure. Patient in good condition five years later.* G. M., male, aged twenty-six years, was admitted to the Out-patient Department of the Memorial Hospital on March 27, 1922, with the following history: In January, 1921, the patient slipped and fell, his right leg doubling under him, and resulting in a fracture of the femur. A tumor developed shortly after at the site of the fracture. As soon as the case was removed, swelling and stiffness in the right knee were noticed. In August, 1921, throbbing pain was felt in the knee. Physical examination on March 22, 1922, showed the knee-joint somewhat profusely enlarged, and incapable of being fully extended. The swelling present seemed to be of bony origin. The patient walked with a limp. From the clinical and X-ray evidence, a diagnosis of giant-cell sarcoma was made.

Radium treatment was given by Doctor Quick. From March 8, 1922, to September 11, 1922, the patient received a total of 98,506 mc. hours in the form of a pack placed at 6 cm. distance.

On June 6, 1922, examination showed the leg to be somewhat smaller, and a slight radium burn to have entirely healed. X-ray pictures showed

that the tumor had materially diminished, although there was evidence of further destruction of bone. On August 5, 1922, the patient was admitted for further radium treatment. On January 31, 1923, the X-ray picture showed some improvement, and some increase in calcareous deposit. On March 21, 1923, the X-rays revealed evidence of a fracture through the cortex of the external condyle, head of the tibia and fibula, with little displacement. On November 12, 1924, there was definite evidence of marked increase in ossification of cortex about the tumor. Further X-ray pictures showed a continuation of this ossification. The patient was able to go back to work at about the end of a year, and has been in good condition ever since. Present condition shows slight limitation of motion at the knee-joint, and one inch decrease in the circumference of the leg two inches above the patella, due to atrophy of the soft parts. Over the outer condyle, there is a thick scab formation, about one inch in diameter, due to an X-ray dermatitis; there is no ulceration; no pain; and no evidence of a recurrence of the disease.

The patient remains in good health, five years since the beginning of treatment. Doctor Coley stated that he was indebted to Doctor Quick for the courtesy of showing this patient.

While there was no microscopic confirmation of the diagnosis, Doctor Coley believed that the clinical and X-ray evidence was conclusive that the condition was a giant-cell sarcoma.

Case VI.—*Giant-cell sarcoma of fibula (clinical and X-ray diagnosis) treated with X-rays alone. Patient well four years later.* T. F., male, aged twenty-eight years, was admitted to the Out-patient Department of the Memorial Hospital on March 29, 1923, having been referred by Dr. C. H. Randall, of Newark, N. J. Nine months before admittance, the patient first complained of pain in the left knee, which was most intense when he tried to walk. This gradually grew worse, and he developed a limp. In July, 1922, he was treated with violet rays for rheumatism. One month later he noticed a swelling at the site of the pain, just below the knee, on the outer side of the left leg. An X-ray picture was taken, and showed a bony tumor originating in the fibula.

Physical examination on March 29, 1923, showed a diffuse swelling occupying the upper third of the left fibula, extending up to within one and one-half inches of the upper end. A clinical and X-ray diagnosis of giant-cell sarcoma of the head of the fibula was made. Doctor Herendeen's report on the stereoscopic plates made at this time is as follows:

"There is evidence of a process in the head of the fibula having its origin in the medullary portion and dilating the cortex equally in all directions; plate presents the features of a giant-cell sarcoma. The soft parts are not invaded; the tumor seems to be still limited by a thin bony capsule. Plate of chest does not reveal evidence of metastasis."

X-ray treatment by Doctor Herendeen was begun on March 29, 1923. The patient was given two exposures, twenty-five minutes each, over the lateral aspect, and one, fourteen minutes, over the left external surface of the head of the fibula. On June 13, 1924, he was given a twenty-five minute exposure to the leg, externally over the tumor.

An X-ray picture taken on June 4, 1924, revealed evidence of further increase in ossification; this process continued as revealed by later X-ray pictures taken on October 17, 1925. The patient was shown at the Memorial Hospital staff conference on March 3, 1927, at which time he was in excellent condition, four years after treatment was begun.

CASE VII.—*Giant-cell sarcoma of lower end of radius, treated by curettage and carbolic acid; a recurrence developed and disappeared under two months' toxin treatment. A second recurrence took place and was treated by heavy radiation for four months. The tumor steadily increased in size and the toxin treatment was resumed, under which, the tumor entirely disappeared and regeneration of bone took place. The patient is well at the present time, seven years later.* M. F., female, aged forty years, was admitted to the Hospital for Ruptured and Crippled on November 28, 1919, with a tumor of the right radius, of four months' duration. This was curetted and the cavity was swabbed out with pure carbolic acid. A section was examined microscopically by Dr. F. M. Jeffries, who pronounced it a giant-cell sarcoma; this diagnosis was later confirmed by Doctor Ewing. A recurrence took place within two months. The toxin treatment was begun and kept up for six weeks, under which, the tumor entirely disappeared. The treatment was discontinued. A second recurrence took place a little over two months later. The patient was then treated with massive doses of radium (a total of 90,000 mc. hours) for a period of four months. During this time, the tumor steadily increased in size, there was no new bone formation, but complete loss of the bony shell. In October, 1920, an amputation was considered, but Doctor Coley decided to give the toxins a further trial. This treatment alone was given for the next four months. Immediate and steady improvement was noticed, with gradual regeneration of new bone filling up the area that had been destroyed by the tumor. The treatment was discontinued in February, 1921, and the patient was discharged. Complete restoration of function took place, there was no further recurrence, and the patient remains in excellent condition at the present time, seven years later.

CASE VIII.—*Sarcoma of the lower end of radius (clinical and X-ray diagnosis was that of giant-cell sarcoma) with complete destruction of the bony shell; treated with systemic toxins. Regeneration of bone took place, and the patient is in good condition, with a useful arm, nine years later.* L. D. G., male, adult, was admitted to the Hospital for Ruptured and Crippled on April 25, 1918. Examination showed complete destruction of the lower three inches of the radius by a tumor that had broken through and completely destroyed the outer shell of the bone; a pathologic fracture had taken place. Amputation had been advised by the other surgeons, and the patient was referred to Doctor Coley by Dr. V. P. Gibney. Doctor Coley decided to try the toxins alone without biopsy as the diagnosis was quite clear, and the treatment was begun at once. At the end of three months, the tumor had entirely disappeared; regeneration of bone had begun to take place, with gradual restoration of function. The patient continued to improve; and at the present time, nine years later, he is in excellent condition with no evidence of the disease remaining.

In this case, the clinical and X-ray diagnosis was that of central sarcoma of the radius, probably giant-cell sarcoma.

The X-ray pictures taken a year after treatment showed almost complete regeneration of the diseased bone and the formation of a new lower end of the radius. The period of treatment and the duration of disability in this case was made shorter than in the cases treated by radiation.

CASE IX.—*Sarcoma (endothelioma type) of fibula with extensive metastases in the groin, iliac fossa and lung; treated by amputation, systemic toxins for four months and one radium-pack treatment to iliac fossa (none to lung). The patient is in good health, with no evidence of the disease, seven years*

later. H. S., male, aged eight years, had always been in good health until January, 1920, when he was struck on the outer side of the right leg, at which site pain and swelling developed shortly afterwards. The swelling continued to increase in size and the patient, in March, 1920, was admitted to the Hospital for Ruptured and Crippled, where he was operated upon by Dr. Royal Whitman. The clinical and Röntgen-ray diagnosis was osteomyelitis. Exploratory operation showed some pus and marked thickening of the bone. This was extensively curetted, and a section examined microscopically and pronounced periosteal round-cell sarcoma.

When Doctor Coley first saw the patient, in consultation, in June, 1920, the lower two-thirds of the fibula was occupied by a large tumor, apparently of periosteal origin, fungating in the central portion; the glands in the groin were enlarged, one being about the size of an English walnut. Doctor Coley advised immediate amputation to be followed by prophylactic toxin treatment. Amputation was performed by Dr. Armitage Whitman, and the patient then given toxins under Doctor Coley's direction. A section of the amputated specimen was examined microscopically by Dr. F. M. Jeffries, who pronounced it a round-cell sarcoma of periosteal origin. Doctor Ewing also examined a section and classified it as endothelioma. A gland of the groin was removed in July, and on microscopical examination was pronounced round-cell sarcoma or endothelioma. The toxin treatment was kept up until mid-August, when, on account of the excessive heat, the patient was permitted to return home. Reëxamination on October 23, showed the inguinal glands to have increased in size; in addition there was a hard mass, the size of a child's head, in the right iliac fossa, evidently involving the retroperitoneal glands. X-ray examination of the chest by Doctor Herendeen showed well-developed, unquestionable metastases of the lung. On October 27, the patient received a radium-pack treatment (10,109 mc. hours at 7 cm. distance) over the iliac fossa. The case was regarded as hopeless and all treatment was discontinued.

In the early part of May, 1921, the patient's father reported that the boy was in excellent health and was attending school regularly. He was examined at the Memorial Hospital on September 19, 1921, at which time there was no evidence of a tumor in the abdomen or groin, and an X-ray picture of the chest failed to show any evidence of the metastasis that had been present in the preceding October. The patient was shown at a clinic held during the meeting of the American College of Surgeons in October, 1924. He is still well with no evidence of the disease, seven years later.

This case Doctor Coley presented to show that in certain cases of the most malignant type of sarcoma of the long bones, soon after extension metastases have developed, tumors may be made to disappear under the system action of the toxins of erysipelas and B. Prodigiosus and the local action of radium and the patient pronounced cured.

Dr. John A. Hartwell, referring to the case presented by Doctor Coley on which Doctor Dudley had previously operated, said that all the growth had been cleaned out. As to whether there had been a recurrence he was uncertain. It was difficult on the evidence of the films to say whether there had been regeneration of bone or a reappearance of the tumor. At the Bellevue X-ray Laboratory it was considered to be a recurrence. There is a great deal of confusion in these cases because of the variations in patho-

logical reports and the X-ray findings. It is often uncertain what one is dealing with, and when Doctor Coley presents evidence that giant-cell tumor of bone may be malignant, one cannot help questioning whether this is the same giant-cell tumor that is known to be non-malignant; particularly when it is shown that there has been considerable difference of opinion between able pathologists who have passed on the sections. The histological evidence of what they are is difficult of interpretation. When we find a tumor that responds to radiation and the injection of toxins and disappears, and when we find apparently the same tumor not yielding but producing metastasis, one cannot help wonder if we are dealing with the same process. Doctor Hartwell thought it was to be regretted that Doctor Coley did not always use the term Giant-cell Tumor, which he did occasionally in his paper while in other places he used the term Giant-cell Sarcoma. It is a tumor and contains giant cells. Therefore the designation adopted by many who have discussed it as giant-cell tumor shows what it is. When it is called giant-cell sarcoma there is an implication that it is malignant, and when in addition it is referred to as benign, one cannot help but feel that the term given it is a misnomer. If Doctor Coley would call them giant-cell tumors there would be less confusion in the minds of those who know so much less about the disease than Doctor Coley does.

Dr. Joseph Wiener said that the remarks of the previous speaker led him to report a case which is apropos to the question whether the X-rays show regeneration of bone or new growth. The patient had had three pathological fractures and was sent to a bone surgeon with an X-ray diagnosis of new growth. A room was engaged at the hospital and the surgeon arranged to do an arm amputation. Doctor Wiener came back from his vacation and saw the plates and examined the patient and expressed his belief that the operation was not necessary as he did not believe there was a new growth present. The operation was postponed and a long series of X-ray pictures were taken here in New York and in Baltimore, and meantime Doctor Wiener treated the patient for the pathological fracture at the lower end of the humerus, but used no radium, no X-rays nor toxins. That was six years ago, and when Doctor Wiener saw the patient last summer he had remained perfectly well. There is often doubt if one is dealing with new bone or a new growth and the speaker never accepted unqualifiedly a radiological diagnosis. He thought this was too often done. Another point Doctor Wiener brought out was the importance of microscopic diagnosis before concluding there was a new growth. There was a case of supposed tumor of the fascia lata admitted to Mount Sinai Hospital, diagnosed as sarcoma, a young woman eighteen years of age. This patient was treated with toxins for five months and the tumor became much smaller. At operation the growth was found to be a lipoma. The clinical diagnosis was sarcoma of the thigh; the tumor was as big as two fists. Had the tumor not been removed it would have been put down as sarcoma of the thigh ultimately cured by toxins.

Dr. William Crawford White said that two years ago he had a patient, a young girl, with a pathological fracture of the humerus. The X-ray diagnosis was giant-cell cyst of the diaphysis. Doctor White showed the plates to two or three of his associates who advised him not to operate as there was a definite feeling at that time that X-ray diagnosis was sufficiently accurate and that anyway the condition could be cured with radium or X-ray therapy. Doctor Blake considered it a giant-cell tumor and advised curetting and putting in a little fat. Nevertheless, Doctor White operated. It turned out to be tuberculosis. The patient is now well.

Dr. Constantine J. MacGuire, Jr., said that three or four years ago, in collaboration with Doctor McWhorter, he collected data regarding some fifty cases from which sections had been examined. Twenty of these were giant-cell tumor and of those twelve were definitely benign. They all ran a straight course and responded to curettage. Of the remaining eight, five recurred locally but without metastasis. That left three. One was the J. S. that Doctor Bancroft spoke of. One was a giant-cell sarcoma, showing giant cells in the section and typical trabeculation. This case was followed for twelve years and backed up the theory of the possibility of a giant-cell tumor becoming malignant. The tumor began to invade the knee-joint and, subsequent to curettage with fat transplant, there was local recurrence. That recurrence showed a mass of spindle cells with no giant cells at all. Amputation was done and there was no further recurrence. A change in the histological picture does often occur, but the speaker did not believe that giant-cell tumors were 20 per cent. malignant. These giant-cell tumors are surgical curiosities; they are different from sarcoma of the bone. If one occurs anywhere near the head of the humerus and it is called a giant-cell growth, one will have to prove it. The speaker did not believe there is any common therapeutic agent that will cure these benign tumors and the malignant ones also.

There was one other point in regard to therapy in giant-cell sarcoma that Doctor MacGuire brought out. They do not as a rule bother the patient unless there is a pathological fracture or limitation of motion in the neighboring joint; the speaker had never seen these factors improved by toxins, radiation or surgery. One can get the production of dense cortical bone around the space by radiation, but the patient is no better off than before. Then, too, how is a pathological fracture going to be cured by toxins or radiation? In five cases of curettage general sepsis resulted and amputation had to be finally done. This danger of infection of the knee-joint after curettage of tibial and femoral lesions is very real and common enough to make one hesitate to curette the larger giant-cell tumors near the knee.

Dr. DeWitt Stetten said he felt that one of the important facts gleaned from Doctor Coley's paper was that giant-cell tumors occasionally are or become malignant. The speaker said he would like to place on record a personal observation of another such case, in addition to those mentioned by Doctor Coley. The patient in question was originally operated on by

Dr. Frederic Kammerer at the Lenox Hill Hospital some fourteen years ago. He was an elderly man with a giant-cell tumor at the lower end of his left femur. A conservative operation was performed, the tumor being thoroughly curetted out. The tumor recurred locally in about three months and it was again curetted. Some six months later the man came under Doctor Stetten's care with diffuse pulmonary metastases, from which he died.

Dr. Walton Martin said that the case of M. C., to which Doctor Coley had referred, has created considerable discussion. Doctor Wood believed, from the appearance of the slides, that it was a malignant growth and advised amputation. From the appearance of the tumor and the X-ray the speaker thought it was a giant-cell tumor and advised radiation after curettage. The boy suffered a great deal of pain following the application of radium and recurrence followed. Doctor Coley amputated the leg and the boy died from metastasis as he has related. Doctor Ewing thought from the appearance of the slide that it was benign. Doctor Wood thought it was malignant. The interesting feature to him, Doctor Martin said, were the different opinions given by two equally distinguished and experienced pathologists regarding the nature of the growth as judged by microscopical examination. It is not always easy to tell from the pathological sections the nature of these growths.

Doctor Coley, in closing the discussion, replied to Doctor Hartwell that, the reason why he does not use the term giant-cell tumor, is, because he believes that these so-called giant-cell tumors are really a type of sarcoma. Doctor Coley stated that this question of terminology was thoroughly discussed by one of the highest authorities on the subject, Dr. Matthew J. Stewart, Professor of Pathology at the University of Leeds, in his paper on "The Histogenesis of Myeloid Sarcoma" (*Lancet*, November 25, 1922), in which the author asserted that these tumors are essentially sarcoma, albeit of only local malignancy in the great majority of cases, and that the giant cells are not fortuitous but a constant and integral part of the growth. With this view, Doctor Coley stated, he was in entire accord. Furthermore, he pointed out the fact that Doctor Ewing, of New York, in his classification of these tumors, divides them into three groups, viz., benign, borderline and malignant.

Doctor Hartwell said he thought there were two different kinds of giant-cell tumors; and he asked how one was to decide the question. The case to which Doctor Martin referred seemed to well illustrate this difficulty. In this case the tumor was pronounced a giant-cell tumor of possible malignancy by Doctor Wood, who advised an amputation. According to Doctor Ewing, it was a benign giant-cell sarcoma of the epulis type, and presented a favorable prognosis. Doctor Bloodgood's diagnosis was benign giant-cell tumor. The patient was treated by curettage and heavy radiation; a recurrence took place, and the limb was amputated; shortly after this, pulmonary metastases developed and proved fatal. This case well shows that in certain cases the most experienced pathologist is unable to distinguish between the benign and malignant types of giant-cell tumor.

Doctor Coley expressed the belief that giant-cell sarcoma is an infectious disease due to some unknown form of microörganism; and that the different clinical types (benign and malignant) may be accounted for by a variation in the virulence of the organism or in patient's power of resistance to overcome this infectious organism. In some patients, the power of resistance is sufficient to hold it in check and keep it from spreading beyond its original site; in which case we have a benign type of giant-cell sarcoma of only local malignancy. In other patients, the virulence of the organism increases or the power of resistance, for some unknown reason, becomes lessened, and after a certain period of time, the tumor becomes more highly malignant and metastases develop.

In regard to Doctor Wiener's case of lipoma treated with the toxins, Doctor Coley stated that, if Doctor Wiener would look up the records he believed he would find that Doctor Coley had never seen the patient; and that, even if he had, the fact that it turned out to be a lipoma had no bearing whatever on the question of the successful use of the toxins in bone sarcoma.

To Doctor MacGuire's statement that he could not see how the same therapeutic agent could cure these benign tumors and the malignant ones also, Doctor Coley replied that it was to answer this very question that he presented before the Society this evening the second case: a highly malignant periosteal sarcoma of the fibula (of the endothelioma type) with extensive metastases in the groin, iliac fossa and chest, that had recovered under toxin- and radium-treatment, and the patient had remained well for seven years. Doctor Coley stated he could cite many other cases in further proof of this point. Doctor MacGuire had asked how a case in which a pathological fracture had occurred could be cured by toxins or radium. To which Doctor Coley replied that, of the group of patients presented this evening, in three a pathological fracture had occurred; that two of these patients had been treated by toxins, and that all were alive and well, with a useful limb at the present time from five to thirteen years.

Finally, Doctor Coley stated that the main object of his paper was to attempt to clarify the great difference of opinions which now existed, as to the proper treatment of giant-cell sarcoma of the long bones. Doctor Coley stated that, while a number of these cases could be cured by surgery, by radiation or by toxin treatment, that a certain number of relapses would follow the use of any one of these methods of treatment; and that he believed the number of cures could be increased and the number of relapses diminished by a combination of surgery, thorough curettage, with systemic toxin treatment, used alone or in conjunction with local radiation. Doctor Coley stated that the advantage that this method had over radiation alone was that it required a shorter period of treatment with a correspondingly shorter period of disability. Doctor Coley stated that, in his experience, in not more than seventy-five per cent. of the cases was it possible to make a positive diagnosis of giant-cell

sarcoma of the benign type, from the clinical and Röntgen-ray evidence alone. Hence, if all cases were treated primarily by radiation alone, a considerable number of lives would be lost, for the reason that when the fact that the tumor was malignant was finally recognized, it would probably be too late to save the patient.

Stated Meeting Held March 23, 1927

DR. JOHN DOUGLAS in the Chair

PURPURA AND ACUTE APPENDICITIS

DR. MORRIS K. SMITH presented a man who was first admitted to the medical service of St. Luke's Hospital, March 4, 1922, complaining of epigastric pain, vomiting, supra-orbital headache and chill. He had been ill two days. The only thing of note in his past history was several attacks of colitis. He was at the time of admission thirty-two years old. There was generalized abdominal tenderness most marked in the epigastrium with slight distention. The temperature was 102, pulse 124, white blood count 34,000 with 85 per cent. of polymorphonuclears. The red cell count and hæmoglobin were normal.

The next day intermittent epistaxis and melena were noted on the chart. On successive days subconjunctival and a few subcutaneous hemorrhages were observed. The platelet count was 50,000, bleeding time 3 m., coagulation time 7 m. Two weeks after admission the red blood count had fallen from normal to 2,000,000 and the hæmoglobin to 38 per cent. In the meantime he had been very ill, at times irrational and incontinent. As an indication of the abdominal condition it is noted that soft solid diet was first allowed twelve days after admission.

As the patient had had several packings of the nares on account of bleeding it is not strange that he developed an otitis media. Streptococcus hæmolyticus was cultured from the pus. A mastoiditis followed and one month after admission he was transferred to the ear service, where mastoidectomy was done, followed by uneventful convalescence. The diagnosis made on transfer from the medical service was purpura hæmorrhagica.

During the ensuing months he gained weight and felt very well. In October, six months after the first admission, he was readmitted with lobar pneumonia. During this stay he had a few gastric symptoms and two weeks after discharge returned for his third admission with the complaint of pain in the epigastrium, coming on at irregular intervals in the day and relieved by vomiting. Although gastro-intestinal series and Ewald test-meal were negative, he was discharged with the diagnosis of probable gastric ulcer.

The next admission was to the surgical service in May, 1923, fourteen months after his first admission. The history at this time was pain across abdomen of two days' duration, localizing in the right lower quadrant, accompanied by nausea and vomiting. There was tenderness and rigidity in the right lower quadrant, the temperature on admission was 100, the white blood count 8000 with 76 per cent. of polymorphonuclears. On account of the past history of this patient operation was deferred in the belief that the abdominal symptoms might be a purpuric manifestation. The next day the blood count had risen, the platelet count was 156,000. The abdominal signs were so definite that the diagnosis of appendicitis seemed clear. At operation a perforated gangrenous appendix was removed. Drainage was necessary. He was discharged on the seventeenth day.

Two weeks later he was readmitted to the medical service on account of

vomiting. The appendectomy wound was healed. There was no tenderness nor mass. No purpuric spots nor hemorrhage were noted. He was discharged well after two and one-half weeks, and has remained well ever since, now nearly four years.

The interest in this case centres in the differential diagnosis between purpura with visceral manifestations and appendicitis. Purpura hæmorrhagica is defined by Minot and Lee in Nelson's Loose Leaf Medicine, "As that condition associated with marked diminution of the blood platelets in which there is spontaneous bleeding from some mucous membrane, usually with purpuric skin lesions." There may be gastro-intestinal manifestations. It may be idiopathic or secondary to toxæmia of some sort. Among other forms of purpura than purpura hæmorrhagica, idiopathic purpura with visceral manifestations, the so-called Henoch's purpura, must be considered. In this condition, however, the platelets are not ordinarily notably diminished. The diagnosis of purpura hæmorrhagica made on the first admission agrees with all the findings in this case and the question remaining is whether it was of idiopathic origin or secondary to a sepsis of appendiceal origin. In view of the subsequent history its seems quite possible that he had acute appendicitis in the first instance to which the purpura was secondary.

Dr. Fenwick Beekman said that some years ago a child was admitted to the Children's Surgical Service at Bellevue Hospital having been sick for two days with vomiting and passing large amounts of bright red blood and mucus in the fæces. Physical examination showed the abdomen to be slightly distended with a large mass in the epigastrium. Operation was done and a large hemorrhage in the mesentery of the jejunum was found. This mass and the hemorrhage from the rectum had led to the diagnosis of intussusception. The following day the skin of this child was covered with petechiæ. Again, one year ago, Doctor Beekman said he saw a child who had arthritis and his physician had been treating him for acute rheumatic fever. On visiting him one day he found the child vomiting, the abdomen rigid and tender and called Doctor Beekman in consultation. There were petechial spots on the skin of the body. The following morning the abdominal symptoms had lessened but other joints were involved. The condition eventually cleared up with the use of salicylates.

DIAPHYSEAL TUBERCULOSIS

Dr. Morris K. Smith presented a child, eight years of age, who first came to the Out-patient Department of St. Luke's Hospital in November, 1919, when she was sixteen months of age. At nine months she had had diphtheria followed by bronchitis. About this period a swelling of the left side of the jaw and the left forearm appeared. It was on account of these swellings, then of seven months' duration, that she was brought for treatment. There was no superficial inflammatory condition. X-ray of the forearm revealed the appearance of a cyst of the ulna in the upper half. Wassermann was negative.

At a visit a month later it was noted that the right elbow was slightly swollen.

She was not seen again until four months later. The swelling in the left forearm had been drained a short time before by an outside physician. There

was an inflammatory focus just above the right elbow and a second over the occipital bone of the skull which were pointing and were incised. A fluctuant swelling over the left malar bone was aspirated and the pus put in a guinea-pig who developed tuberculosis. A few days later the focus in the left side of the mandible broke into the mouth.

She was then admitted into the hospital. He curetted all the foci with the exception of the occipital obtaining small sequestra from those of the ulna

FIG. 1.—L. S. Tuberculosis of shaft of ulna in 1920.

FIG. 2.—Same as Fig. 1, seven years later.

and humerus. She ran temperature for about two months. The pathological diagnosis was tuberculous osteomyelitis.

Thereafter she was treated as an Out-patient. Sequestra were occasionally extruded. In October, 1922, about three years after she originally presented herself, it was first noted that all wounds were healed. One or another opened occasionally until a year later, since when all sinuses have remained closed. The duration of the disease from the first appearance of the swelling when she was under a year of age until dressings could be permanently discontinued was between four and five years. The child is now eight.

The reporter questioned whether curetting the various foci in this patient contributed much to the ultimate good result, although it was inevitable that the foci should have been drained. It is conceivable that the focus in the left ulna could have been radically removed when she first applied if the diagnosis had been clear at that time. He could not believe that the end result would have been better in the case of this particular bone and as there were already other foci to which a radical removal was not applicable, it does not seem as if it would in any event have been wise. The credit of the cure in this case must be given to the mother who faithfully kept the child outdoors.

TUBERCULOSIS OF TENDON SHEATH

He presented this patient for two reasons: First, on account of the relative infrequency of diaphyseal tuberculosis in this country, and second, as an instance of complete restoration to health in a child presenting tuberculosis of the ulna, humerus, mandible, malar and occipital bones.

LOOSE BODY IN INTERPHALANGEAL JOINT

Dr. Morris K. Smith presented a young woman. About a year before applying for treatment in January, 1926, she struck the end of her right index finger against a projecting object as she was going down stairs. Since that time the finger has been swollen and painful on use. On examination there was a moderate spindle-shaped swelling centring at the proximal interphalangeal joint, which was sensitive. Flexion at this joint was somewhat limited. At times a click could be demonstrated. X-ray was negative.

Under paradigital anæsthesia a lateral incision was made over the joint. On incising the capsule a relatively large amount of the joint fluid escaped and a sliver-like firm body, one-third of a centimetre in length, popped out. It was free except for an attachment at one end to the inside of the joint. Doctor Smith thought at the time that it must represent a fragment of cartilage torn loose at the injury from which the condition dated. The pathological report was, however, chronic inflammatory fibrous tissue. There was no question, nevertheless, but that it acted as a loose body in the joint. Improvement dated from the time of intervention and the patient has a satisfactory result.

Loose bodies in larger joints, particularly the knee, are common enough, but he could not recall having seen reference to such a condition in a finger joint. This case is therefore presented to illustrate the fact that a loose body may occur in a finger joint as an apparent result of trauma, that it can cause disability, and that its removal will cure the condition.

Dr. Hugh Auchincloss asked Doctor Smith if he did not think this body might be a fragment of one of the glenoid ligaments. Personally, he thought this might be so, although he had never seen one free. He asked Doctor Smith if he remembered whether the body came from the front or the back of the joint. There are really glenoid ligaments in the back as well as the front of the joint. The front is considerably larger.

Doctor Smith said that when he operated on the patient he thought this body looked like a fragment of cartilage. The pathological report, however, was fibrous tissue. Incision was made along the lateral side of the finger and as soon as the opening was made this little body popped out. It was attached by one end. Doctor Smith did not remember whether it came from the front or the back of the joint, but he thought Doctor Auchincloss's explanation might be the correct one.

TUBERCULOSIS OF TENDON SHEATH OF INDEX FINGER

Dr. Morris K. Smith presented a woman who came to him for treatment for a swelling of the proximal two-thirds of the left index finger. It involved the flexor side most prominently where it was cystic, but extended on the dorsum where there were nodular elevations, and into the palm for about 2 inches. She was unable to flex the proximal interphalangeal joint

on account of the swelling. The finger was not at all painful and did not appear to interfere particularly with her use of the hand. The duration of the condition was five years. She has never been ill.

At operation, February 23, 1927, she was found to have a tuberculous teno-synovitis of the sheath of the index finger which involved also the extensor tendon of the finger below the knuckle. The process was hygromatous with numerous rice bodies. Pathological examination confirmed the diagnosis. The case presents an uncommon location of primary tuberculous teno-synovitis. In his limited experience of this disease in the hand, hitherto it has been found in the palm or dorsum.

FIG. 3.—Tuberculosis of tendon sheath of index finger.

Kanavel in S., G. and O., for November, 1923, reports fourteen cases of tuberculous teno-synovitis of the hand. There was one in which six years after operation a development of the infection in the index finger sheath appeared. He does not mention any primary isolated finger sheath involvement.

DR. HUGH AUCHINCLOSS said he had seen a few of these cases and remembered operating on three or four. There are certain things about them that are interesting. One is the degree of motion these patients have when tuberculosis is confined to the digital sheath. They may not be tightly contracted at all. The other point of interest is that all of these patients told a story of long-existing swelling, moderate disability, and pain or discomfort, particularly on excessive use. They did well following complete excision of the sheath. Although this is tedious to do, and one should preserve annular bridges to provide pulleys for the tendons, it is well worth while, for it gives increased function very soon. Doctor Auchincloss had seen two of his cases after several years and they have not had recurrence. Tuberculosis of the tendon sheath of a finger is of course not as common as that of the radial or ulna bursa.

CONGENITAL STENOSIS OF THE DUODENUM

DR. RICHARD W. BOLLING presented a five months' old female infant who was referred to him by Doctor Lowenthal in October, 1926, when she was two weeks old. The history was of vomiting since birth, projectile at times, and the vomitus was usually bile-stained. The stools, at first typical meconium, subsequently contained small amounts of curds. Röntgenograms

by Doctor Goldfarb showed almost complete obstruction of the duodenum with great dilatation of the proximal segment. The baby appeared to be in very poor condition and weighed six pounds, a loss of one and one-half pounds since birth. The abdomen was not distended and there was a definite purulent discharge from the umbilicus. She was admitted to the Babies' Hospital, transfused with 80 c.c. of blood and operated on. The stomach and pylorus were found dilated and there was an enormous dilatation of the duodenum extending into the third portion. The cause of the obstruction was not demonstrated. The remainder of the small intestine was collapsed. The jejunum, about 3 cm. distal to the flexure, was applied to the anterior wall of the third portion of the duodenum and an anastomosis effected by means of three rows of interrupted and continuous fine silk sutures. A stoma about 1 cm. in length was formed. Convalescence was relatively uneventful with slight vomiting and some wound infection. The baby was discharged twenty-three days after admission in good condition, having gained 670 grams. To illustrate the anatomical condition a specimen that was removed at autopsy on a similar case is shown. (Fig. 6.) The baby now is five months and ten days old and weighs sixteen pounds. Doctor Bolling presented this patient to emphasize the very real importance of a röntgenographic examination in babies who vomit from birth. The procedure is simple and harmless. He presented a similar case before this Society in December, 1925. In that instance the obstruction was complete. That child is now seventeen months old and weighs twenty-five pounds.

FIG. 4.—Congenital stenosis of duodenum at two weeks. Röntgenogram after opaque meal.

DR. EDWARD W. PETERSON said that he had operated upon a two weeks' old infant for stenosis of the duodenum. The obstruction was due to a diaphragm which involved about half the lumen of the gut. An operation similar to the Horsley pyloroplasty gave a very satisfactory opening. Unfortunately, however, the infant died a few hours after the operation.

STREPTOCOCCUS PERITONITIS

DR. RICHARD W. BOLLING presented two patients together in whom the clinical features and pathological conditions were almost identical. The first patient, Margaret, came under his care at St. Luke's Hospital in February, 1926. At that time she was six years old and had been ill five days. At first she had been constipated and had been given several cathartics. On the second and third days of her illness she had a chill and high fever. At this time she was thought to have pneumonia. On the day before admission there was severe abdominal pain, at first general and later localized in the right lower quadrant. Vomiting was frequent and persisted throughout the day. On the afternoon of the day of admission there were repeated foul, watery stools. On admission the child appeared acutely ill, the abdomen was moderately distended, resistant throughout and there was right rectus rigidity. Tenderness was general but most marked in the right lower quadrant. The temperature was 101.4° on admission but rose to 104° immediately before operation. The leucocytes were 23,800, polymorphonuclears 84 per cent. The diagnosis was acute appendicitis with spreading peritonitis. On opening the peritoneal cavity there was thin, turbid fluid containing numerous flakes of fibrin. The appendix appeared œdematous and congested. This was also true of the adjacent cæcum. The appendix was removed and the wound closed without drainage. The peritoneal exudate gave a pure culture of streptococcus hæmolyticus. The pathological report was acute appendicitis. The report in full was as follows: Macroscopic examination. Appendix 4.8 cm. long, opened in operating room. Serosa a little dull but not hemorrhagic and mucosa and other coats appear normal. Microscopic examination. Sections show an acute inflammation with extensive lymphoid infiltration in all coats, organizing adhesions on surface in which there are also many polymorphonuclear cells and a fairly well-preserved mucosa, although the small vessels in it and the submucosa contain a very large number of polymorphonuclear cells."

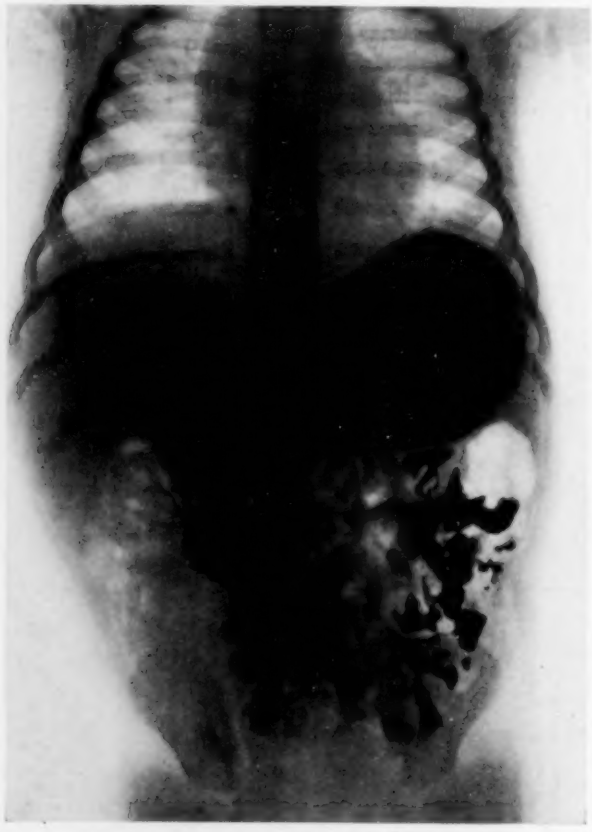

FIG. 5.—Same case as Fig. 4, five months after duodeno-jejunostomy. Röntgenogram after opaque meal.

Doctor Bolling did not believe the appendix to be the source of the peritoneal infection. Twelve hours after operation the child appeared in extremis, cyanotic, pulse rapid, thready, and with a temperature of 105.4°. Blood transfusion of 200 c.c. was followed by a most dramatic improvement and two days later when the condition again seemed precarious a second transfusion of 180 c.c. was again followed by marked improvement. Following this convalescence was complicated by wound infection and the development of a secondary abscess in the left lower quadrant which necessitated drainage. She was discharged in good condition sixty-two days after admission.

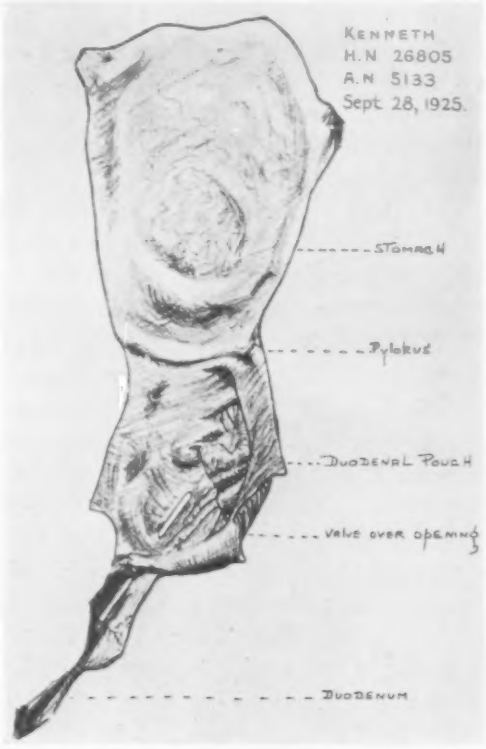

FIG. 6.—To illustrate pathology of case shown in Figs. 4 and 5. Specimen removed at autopsy in similar case.

The other patient, Ellen, came under his care at St. Luke's Hospital in May, 1926. She was six years old and had been ill five days. During this entire period she had suffered from abdominal cramps and high temperature, for two days there had been nausea and vomiting. On day of admission pain was referred to the right lower quadrant. There had been two similar attacks two and three years previously and she had recovered from an attack of measles one month before. On admission the child appeared acutely ill, abdomen slightly distended, resistant throughout and slightly more tender in the right lower quadrant. Temperature was 104.4°, pulse rapid and thready, leucocytes 30,900, polymorphonuclears 80 per cent. A diagnosis of diffuse peritonitis, probably due to streptococcus or pneumococcus infection was made, but as an acute appendicitis could not be ruled out an exploratory operation was done. The peritoneum was congested and its cavity contained thin turbid fluid. The appendix appeared normal save for the congestion of its peritoneal coat. It was removed. The peritoneum was closed and the wound in the parietes was closed to a rubber dam drain. The peritoneal exudate gave a pure culture of streptococcus hæmolyticus. The pathological report of the appendix was peri-appendicitis. The convalescence was almost identical with that of the preceding case save that only one transfusion of 250 c.c. was given. A secondary abscess in the left lower quadrant was drained on the twelfth post-operative day and the patient was discharged in good condition thirty-three days after admission. These two patients are presented to emphasize the value of the transfusion in acute infections. The procedure seems to be of particular value in infants and children.

Dr. Edward D. Truesdell stated that he had two cases of streptococcus peritonitis in children under his care at the present time. Both of these were little girls, ages two and four. One of these cases was undoubtedly going to die; the other appeared to be on the way to recovery one week after operation.

The peritonitis in the case doing badly was secondary to a streptococcus cellulitis in the region of the vulva. There was a positive blood culture, with very high temperature and marked prostration.

In the case progressing toward recovery the peritonitis apparently had its origin in a pharyngitis with enlarged nodes in the neck. In this case three blood cultures were negative, the temperature was not so high and the intoxication was not sufficient to cause prostration.

In both cases exploratory laparotomy was done and cultures made. The appendix in each case was obviously innocent and not removed. Both cases were drained.

Dr. Fenwick Beekman said that during the last six years on the Children's Surgical Service at Bellevue Hospital, there had been nineteen cases of primary peritonitis in children, fourteen of which were of pneumococcic origin and five streptococcic. All the streptococcus cases died and they were all in boys. Some years ago Rabinowitz published a series of cases of streptococcus peritonitis, eight in all, and seven were girls.

Dr. Edward W. Peterson has under his care on the Babies' Ward of the Post-Graduate Hospital at the present time an eight-year-old boy, who had been under treatment on the medical side for nephrosis. There was general anasarca. There was considerable fluid in the abdomen, and the œdema of the face, scrotum, and extremities was marked. Suddenly the boy began to complain of severe abdominal pain and to vomit, and the temperature rose to 104°. Examination was somewhat difficult, owing to the ascitic fluid, but as the pain was chiefly on the right side, a tentative diagnosis of acute appendicitis was made and operation advised. At operation a large amount of turbid fluid containing lymph flakes was evacuated from the abdomen. The appendix was somewhat injected but was not responsible for the peritonitis. The abdominal fluid showed pure culture of streptococcus hæmolyticus. Within twenty-four hours after operation the general anasarca had disappeared entirely and there followed a condition of extreme tissue dessication. The child was *in extremis*, not responding to the usual measures employed to overcome the dehydration. A blood transfusion was given and, just as in Doctor Bolling's case, was followed by the most magical improvement in the patient's general condition. During convalescence a pneumonia developed, but at the present time the boy has entirely recovered from his peritonitis and his pneumonia. There is a slight tendency, however, for the kidney condition to revert to its former status.

PERFORATED DUODENAL ULCER. CLOSURE BY IMPLANTATION OF GALL-BLADDER

Dr. Richard W. Bolling presented a man, forty-two years of age, who was admitted to the medical service at St. Luke's Hospital, February 24 of

this year, with a diagnosis of duodenal ulcer. His hæmoglobin was 55 per cent. and his red cells 3,000,000. On the morning of the third day after admission he complained of severe abdominal pain. The diagnosis of perforated ulcer seemed fairly definite and he was operated upon at once. There was found a quantity of turbid, bile-stained fluid in the peritoneal cavity; the proximal duodenum and the pyloric end of the stomach formed an indurated mass adherent to the gall-bladder. It was not possible to definitely locate the pyloric ring. Intestinal contents were leaking from a hole in the upper surface of this mass at its junction with the gall-bladder. The gall-bladder was gently separated from the inflammatory mass and a perforation somewhat less in size than a twenty-five cent piece was revealed. The margins of this perforation were indurated for some distance. A finger introduced into the lumen located the pyloric ring as being situated on the stomach side of the opening, showing that the perforation was situated in the anterior wall of the first portion of the duodenum. It was impossible to tell from the appearance and feel of the mass whether it was simply inflammatory or not. Closure in the usual way was not feasible, so he reapplied the gall-bladder and sutured it carefully to the duodenum, easily and completely occluding the perforation. A posterior-gastro-enterostomy was then done. The patient's convalescence was uneventful and he was discharged from the hospital on the eighteenth day. This is the first time he had ever seen a perforation in the duodenum which could not be closed by suture.

Dr. Hermann Fischer thought that it is not so very rare that one has difficulty in closing a perforation in the stomach or duodenum on account of acute inflammatory changes of their walls. Doctor Bolling's idea of using the gall-bladder as a cover for the perforation is undoubtedly of value. Another method of value under such conditions is to insert a catheter or a rubber tube which fits snugly into the hole. This is pushed through the pylorus into the duodenum. The tube and the wall of the stomach close to the perforation are surrounded and covered by a cuff of omentum which is fastened with the tube on to the parietal peritoneum. The patient can then also be fed through the tube the first days after the operation. The tube is removed on the fifth or sixth day. Usually there is no leakage and the small fistula heals in a few days.

CARCINOMA OF SPLENIC FLEXURE OF COLON—PRIMARY RESECTION

Dr. Hermann Fischer presented a woman who entered the hospital in September, 1926, complaining of pain in abdomen and constipation. Her menstrual history was that for some time back she had been flowing more profusely, had suffered from backache and general discomfort in abdomen. The pain in her abdomen came in attacks sometimes very severe and often nauseated her. The pain was of colicky character and occurred mostly on the right side in the region of the cæcum. Her appetite was fair but she was run down and nervous.

Examination.—Shows abdomen somewhat generally distended, more so on the right side than on the left. No visible peristalsis. Directly above the symphysis the abdomen is quite tender on pressure. There is an indistinct irregular mass in the lower abdomen which, however, cannot be mapped out very clearly on account of the distention and general sensitiveness of the abdomen.

Bi-manual vaginal examination reveals a large myoma of the uterus with an inflammatory mass of the left ovary and tube. No blood or mucus in stool at any time.

September 20, 1926, a supra-vaginal hysterectomy was done.

It was found that beside the myoma of the uterus there was a large hemorrhagic cyst of the ovary and a chronic salpingitis. This mass was tightly adherent to the lower sigmoid flexure, pulling it down deeply into the pelvis. The gut above was somewhat distended and it was thought at the operation that this tumor of the adnexa had caused the obstructive symptoms.

She made an uneventful recovery from this operation and was ready to be discharged when she was again seized with acute abdominal pain with vomiting and distention and inability to pass fæces. This, however, was easily overcome by high oil enema. She left the hospital the next day and went to the country to recuperate.

There, however, her attacks of constipation recurred. She was treated by a local physician with high enemata but she was only partially relieved and therefore reëntered the hospital in November.

On reëxamination there was found a uniform distention of the whole abdomen and a careful X-ray examination showed that the point of obstruction was in the transverse colon near the splenic flexure.

She was re-operated upon November 17, 1926, and a scirrhous carcinoma was found. This was removed by resection and by mobilizing the descending colon a lateral anastomosis between colon transversum and descending colon was done. From this operation she made a good recovery; up to the present time she has gained 20 pounds in weight and is feeling perfectly well.

Dr. Morris K. Smith recalled a similar case operated upon by him several years ago. The patient was a middle-aged woman with large bilateral ovarian cysts. The abdomen was distended. Her constipation and gas symptoms were attributed to pressure caused by the cysts. At operation after removal of the cysts Doctor Smith on putting his hand in the pelvis encountered a further mass. He lifted it up and it was revealed as an annular carcinoma of the sigmoid. He did a resection and there was a satisfactory recovery, which proved to be only temporary, for the patient had recurrence one year later.

Dr. John Douglas said that it is not unusual to find a secondary pathological lesion that causes symptoms after the primary condition, which was thought to be the cause of the illness has been removed. The speaker saw a case not long ago sent in to the hospital with a diagnosis of appendicitis. The patient also had a uterine fibroid. The surgeon made a midline incision and first examined the appendix and then took out the fibroid. He looked again at the appendix and found an annular carcinoma, situated at the ileocæcal valve. He did a resection and the woman made a good recovery. Another case, operated on for uterine prolapse, had hemorrhage from the bowels while recovering. Three months later she got up an acute obstruction and carcinoma of the descending colon was found. This had evidently been

present at the former operation. In another case a man operated on for umbilical hernia got up an acute gall-bladder inflammation while recovering from the operation for the hernia. It is not uncommon for a secondary lesion to be present and it is doubtful how missing this can be avoided unless one makes a complete intra-abdominal search which is not always practicable.

MEGACOLON—INDICATIONS FOR SURGICAL TREATMENT

Dr. Richard W. Bolling read a paper with the above title, for which see page 62.

Dr. Leon T. LeWald (by invitation) said that he made his first X-ray examination of a case of megacolon about 1912, and had seen about ten of these cases since then, several of them being some of the cases shown by Doctor Bolling; others were seen at the University and Bellevue Medical College Clinics. One interesting observation was the apparent obliteration of the liver shadow. Doctor LeWald had called attention to this in his book, "Digestive Disturbances in Infants and Children," in which he said, "In this connection a very interesting observation may be made, namely, that the gas contained in the dilated bowel permits such an easy penetration of the body that the liver shadow may not be visible. One is likely to misinterpret the Röntgen appearance and believe that the liver has been displaced by the colon. Careful study in various positions, especially exposures made with the patient in the dorsal position and the ray passing from before backward, will reveal the liver in the normal position with the colon superimposed upon it." A case of Dr. J. Alexander Miller's was shown to the speaker a few days ago in which the *apparent* absence of the liver shadow had been noted. It is a peculiar phenomenon and is illustrated in one of the slides shown by Doctor Bolling. If a *lateral* view is taken the liver shadow will be seen *behind* the dilated colon. The exact explanation is not easy. One explanation is the displacement of the denser structures by the distended colon, and hence the X-ray has less tissue to penetrate, consequently causing more exposure over that region of the X-ray film, and producing a density which obliterates the usual shadow. It looks, however, as if the X-ray, in passing through the gas-filled colon, is in some way influenced so that it penetrates the denser structures, such as the liver, more readily, and thus produces overexposure of that portion of the film and obliterates the usual shadow of the liver. The speaker agreed with Doctor Bolling as to the way in which some of these cases go on for years with little in the way of symptoms. If one ever expected to see a case of so-called toxic absorption, one would look for it in these cases. And yet in all of the cases he had seen the speaker had found little evidence of toxic absorption. It may be that they become immune to the absorption of toxic material from retained fecal matter and by-products of intestinal stasis.

Dr. John C. A. Gerster reported the case of a boy of eleven with megacolon, operated on by Dr. A. A. Berg, in which only three or four inches of rectum were left. Within three weeks the child was skin and bone from dehydration. There were repeated diarrhœal movements at this time. Doctor Schick, the pædiatrician, suggested subcutaneous injections of olive oil (about 100 c.c. per day) and slow but distinct improvement began and continued. The treatment was kept up for six weeks and recovery ensued. Some of the olive oil encapsulated but this was of no moment.

BOOK REVIEWS

GYNÆCOLOGICAL DIAGNOSIS AND PATHOLOGY. By A. H. F. BARBOUR, M.D., LL.D., Formerly Lecturer on Gynæcology in the University of Edinburgh, and B. P. WATSON, M.D., F.R.C.S., Ed., Professor of Obstetrics and Gynæcology in Columbia University. Third Edition Reprinted. New York, William Wood and Company, MDCCCCXXVII. Octavo, cloth, pp. 223.

The text is beautifully planned, carefully and fully executed and supplemented by pertinent, profuse illustrations. There are two main divisions in the book. The first occupies thirty-four pages and deals with methods of diagnosis. The second occupies the remainder of the book and considers the pathological conditions. This is not in any sense a text-book but is more a guide to the method of study of gynæcology. The authors have taken the specimens that have been examined by themselves over a period covering several years. Naturally these include the more frequent gynæcological problems confronting the surgeon. In the text the pathology relative to the clinical conditions is carefully described. Accompanying the descriptions there appear illustrations of the gross condition. These are followed by microphotographs which depict the cellular histo-pathology. In spite of its apparent brevity the subject matter is so condensed and so concisely presented that it covers almost every conceivable gynæcological condition.

In revision of the text for this last edition the changes have concerned themselves mainly in the portions dealing with the support of the uterus, the etiology of its displacements and with inflammations occurring within it. For the gynæcologist primarily and for the general surgeon as well as for the internist and diagnostician, this book cannot be too highly recommended.

MERRILL N. FOOTE.

THE TREATMENT OF FRACTURES. By CHARLES LOCKE SCUDDER, M.D. W. B. Saunders Co., Philadelphia, 1926.

The tenth edition of Scudder's, "The Treatment of Fractures," has appeared and is a remarkable compilation of the advances on the subject of fractures which have occurred since the publication of his last edition.

Doctor Scudder has drawn his material from many sources and has added special chapters on, Pathological Fractures by Bloodgood, on Bone Repair by Bancroft, on Fracture of the Mandible and Maxilla by Thoma, all of which are satisfactory additions to a work of this character.

Many of the chapters are encyclopædic in their handling of the lesion under discussion and Scudder has gone to great pains to give all the accepted forms of surgical therapy for the fracture under discussion. In many cases it would be more instructive did he give the method which he considered the most satisfactory, but for the student of the subject his is the comprehensive

method and gives the reader the choice of one of the several methods in use.

The chapter on fracture of the femur is an especially valuable one and worthy of close reading and his remarks upon the desired result, that is the result which should be obtained by the treatment, are worthy of italics. The separate consideration given to fractures of the femur in children is especially commendable.

Chapters 20 to 26 inclusive, which deal with the operative treatment, are very completely handled and especially well illustrated.

Chapter 28, which deals with massage and mobilization, is respectfully called to the attention of the surgeons, who expect to handle fractures, as the subject is beautifully condensed, and Scudder's remarks upon the inadequacy of this form of therapy and the lack of understanding of its usefulness and its dangers is worthy of careful reading.

As a whole, the book is a remarkable compilation of the knowledge and therapy of fractures and I believe marks an epoch in the American literature upon this complicated subject.

JAS. MORLEY HITZROT.

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